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QUEENSLAND

COTTON RESEARCH STATION, BILOELA

BY
W. G. WELLS.

Introductory Note.

This progress report on the investigations conducted at the Cotton Research Station during the 1942–43 season has been prepared from the reports submitted by the same officers as were mentioned in the 1941–42 report.

Meteorology.

The rainfall from June 30th, 1942, to July 1st, 1943, totalled 23·54 inches—4·72 inches less than the mean annual rainfall over the past 20 years. The number of wet days experienced, however, coincided with the mean number for the 20 years, the mean daily rainfall thus being lower than usual. The mean rate per hour of the precipitation during the total period of actual rainfall for the season was only 0·106 inches as compared with a mean of 0·159 inches for the four previous seasons in which the automatic recorder has operated at the Research Station. Less rainfall occurring at the rate of 0·75 inches or more per hour was experienced as compared with the mean of the previous four years.

The wet days were rather separated, except for short periods during December, January and February, so that the combination of the crop's use of much of the moisture from the lighter storms and the frequent lack of rainfall sufficient to insure deep penetration of the soil, made the crop largely dependent on subsoil moisture. As there was little reserve subsoil moisture owing to the rainfall having been below the average between May and December, the plants reacted quickly to dry conditions during January and March when sub-normal rainfall was received.

The temperatures for the season may be summarized as follows :— July to December tended to be warmer than usual except October which was slightly cooler. The mean maximum reading for December was 5·8° F. cooler than the previous mean for that month, but the mean minimum was 1·5° F. higher than the previous mean, scattered showery weather over the month accounting for these conditions. January and February were normal, but the very dry weather in March and April caused the mean maximum readings to be 2·3° and 3·8° F. respectively above the previous means. May was normal, but June experienced subnormal maximum and minimum readings. The first killing frost occurred on June 18th, which is considerably earlier than for some years past, the first frost in the previous season being on July 27th.

Genetics and Breeding.

The jassid-resistant cotton breeding programme has now reached the stage where a slightly resistant Miller bulk selection, 41.J, is being distributed commercially, while one pure Miller strain known as III–26 is being multiplied for distribution as a very jassid-resistant cotton. While displaying some defects in plant habit and boll size, the latter has shown itself in trials to be consistently prolific and resistant and to be uniform for most characters, including unfortunately a lint length of only $\frac{15}{16}$″ to 1 inch. The fibre is very strong and full-bodied, while the lint percentage promises to be higher than that of commercial Miller. On present market requirements this type of lint would command, however, a ready sale.

In addition there have been isolated in the third generation after backcrossing, three hybrid strains with staple lengths of 1 inch and better, and all producing full-bodied, very strong lint with lint percentages on a level with that of commercial Miller, *i.e.*, 33·5–34·5 per cent. These hybrids, which are selections from (Mi×U.4)×Mi backcrosses, are very jassid-resistant and while re-selection is being continued, they appear sufficiently uniform in essential characters to warrant testing extensively. Consequently two or three acres of each will be grown in isolation in the coming season to provide seed for full-scale testing and demonstration.

The breeding plots proper yielded material of some interest. In the Miller plot, some groups of related progenies continued to show uniformity of plant type and lint characters within the family, combined with jassid resistance. Some of these families appear more desirable types than III–26, and may replace it after adequate testing. III–26 has been so uniform that it is unlikely to respond rapidly to further attempts to improve it by individual plant selection, although this phase of the work is being continued.

Further backcrossing in the Miller backcrossing project has been discontinued now that there exist F_2's of 2nd backcrosses, F_1's of 3rd backcrosses and new 4th backcrosses. All these approach the general boll and lint characters of the recurrent Miller parent, while it has been possible to maintain by selection a high degree of resistance. This is checked by including in the plot a series of jassid-susceptible commercial varieties. Since the heterozygosity of the commercial Miller has necessitated the maintenance of a large number of backcross strains of each generation, the cessation of further crossing will enable more attention to be devoted to a study of the existing material.

The Cliett selections described in a previous report were planted again, this time with success. One progeny showed great uniformity for resistance, hairiness and plant type, the latter being extremely vegetative. The bolls were small, the lint appeared weak and wasty, and the strain shows little promise of yielding a commercial fibre. The remaining 10 progenies exhibited varying degrees of segregation for resistance and other general characters. Plant selections were made, but the lint quality throughout was not promising.

Since New Mexico Acala has been gaining in popularity on account of its production record, and as the plant, boll and fibre characters, with the exception of fibre strength, are better than those of Miller, it has been decided to incorporate this variety in the programme for breeding jassid-resistant types, for it has the disadvantage of being very jassid-susceptible. The variety is relatively constant, phenotypically, and the difficulties caused by the heterozygosity of Miller should not occur in this project. It is proposed to use two resistant parents :—the apparently immune Ferguson from Trinidad, and one of the Rhodesian strains. Ferguson, which is very late and vegetative under Callide Valley conditions, has been crossed with a Miller strain (fairly leafy and late) and the quick-maturing open Triumph variety so that its behaviour in crosses may be studied.

The programme of improvement of the commercial strains of the Miller variety was so seriously affected by adverse seasonal conditions that little progress can be reported. The main progeny breeding block, which was located in a district adjacent to the Research Station, yielded so lightly that little could be done other than to pick separately the five most promising strains for further testing and multiplication. A small supply of bulk selected seed was obtained from a commercial field of the leading strain 41.S where more favourable conditions promoted a yield of roughly 500 lb. seed cotton per acre. Several promising selections were also obtained for further testing.

The better moisture conditions in the New Mexico Acala breeding block than in the Miller progeny area, which was also located away from the Research Station and at some distance away from the Miller centre, resulted in more satisfactory yields being produced. No strain displayed any outstanding merit, however, over either the rest of the strains or the fairly satisfactory standard of the commercial stock. Accordingly a supply of bulk selected seed from apparently superior plants was obtained as a source of replacement stock, as well as a number of very promising selections for progeny testing.

The testing of the relative merits of the most promising Miller progeny strains against the main commercial strains of this variety was continued at the Research Station. The area of land in the third year of cultivation out of native grassland selected for this test displayed a most unexpected lack of supply of subsoil moisture. Examination of the subsoils indicated that a pronounced dry hard zone occurred just below the depth of ploughed soil. As this phenomenon has not been noticed in the two previous seasons' use of this area, it is possible that the torrential rains yielding approximately 11 inches in five days in the previous February, tended to solidify the upper subsoil, for the very permeable surface soil of this area has a high rate of intake for such rainfall. The lack of satisfactory penetration of rainfall this season would thus prevent the storage of sufficient moisture in the consolidated subsoil to carry the cotton plants through stress periods. A very irregular growth resulted and the plants reacted severely to dry periods in January. Following the 1943 February rains, all

strains developed a leafy vegetative growth which showed signs of extreme stress late in March when considerable leaf shedding occurred. Little or no crop was produced by any strain.

More satisfactory results were obtained in a November planting of the most promising strains of the quick-maturing Triumph variety. This test, while located only a short distance from the Miller strain test, was planted on a heavier soil type which tends to crack in dry weather and the December rainfall apparently penetrated further than in the lighter soil type. No significant differences in yields were obtained in the test, the mean yield being 680 lb. seed cotton per acre, which must be considered very good for the seasonal conditions experienced. The three strains producing the best yields in the test have consistently given good results in both strain tests and demonstration plots however, so it is considered that the lowest yielding strains can now be eliminated with safety.

Agronomic and Varietal Experiments.

A light showery fall of one inch of rain occurring on October 20th allowed of the planting of 16·5 acres of new cultivation where the open texture of the surface soil enabled the moisture to penetrate to sufficient depth to maintain the resultant seedlings. Useful rains early in November thoroughly established the first plantings and allowed of another 35 acres of cotton being planted. The rest of the experimental area, 18·2 acres, was planted early in December following 0·76 inches of rain.

The late October-planted areas made a fairly normal development except that a considerable amount of terminal loss was caused through early attacks of thrips, corn ear worm and rough bollworm. The November plantings tended to be of a more vegetative type and also suffered more terminal loss. The December plantings, while experiencing little terminal loss, made a rankish vegetative growth during December and January which was not conducive to early flowering. A heavy insect attack occurring during February practically destroyed the whole of the small crop that had been set on the late plantings.

The average yields of cotton obtained on the soil types of the Research Station representative of the major alluvial soils on which cotton is grown in the district were as follows :—

October plantings	...	462 lb.	seed cotton per acre.
November „	...	398 lb.	„ „
December „	...	27 lb.	„ „

The yields obtained in many of the later-planted experiments were, therefore, of little value and will not be reported in the following descriptions of the experiments conducted.

Main Varietal Test.—This experiment, in the form of a 12×6 randomized block experiment, was a further test of new varieties to

the district and varieties which had previously shown some promise in earlier tests, against the standard varieties of the district. Unfortunately it was located on the same soil type as described for the Miller strain test, and no yields were obtained.

Varietal Tests for Mechanical Harvesting Trial.—Investigations into the merits of mechanical harvesters were provided for by the planting of five varieties in a 5×4 long-faced randomized block. Unfortunately the almost complete loss of terminals through insect attacks caused the development of a rank bushy type of plant that was entirely unsuitable for machine harvesting, and no trial of the machine was carried out, the area being hand-picked as a varietal test.

The bushy plants reacted severely during dry periods and also suffered from corn ear worm attacks so that only a light bottom crop was produced. Under the circumstances the earlier-fruiting varieties produced the most cotton, Triumph Lot 124 significantly outyielding the slower-fruiting New Mexico Acala and Miller between which there was no difference.

Combined Varietal and Rotational Trial.—This investigation was continued along the lines previously reported. The cotton areas could not be planted until November 11th and with the erratic season experienced there was a definite premium on ability to develop the crop quickly when conditions were favourable. The soil in this series of plots is similar to that on which the rain-grown Triumph strain test was conducted and consequently the plants reacted less severely to the seasonal conditions. The quicker-fruiting Triumph consistently out-yielded Miller in all rotations.

In the rotation trials, cotton following cotton yielded appreciably less than did cotton following any other crop. Cotton following Sudan grass yielded the highest of any rotation, 701 lb. seed cotton per acre as compared with 328 lb. where successive crops of cotton have been grown. Cotton in the 2nd year following Rhodes grass yielded second best—637 lb. seed cotton per acre. The high yield following Sudan grass is unusual as this rotation has only exceeded all other rotations involving annual crops four times in 11 years. No explanation can be offered other than that, with the long dry period to December, the Sudan grass stubble which was ploughed under in late July did not decompose sufficiently to provide an excessive supply of nitrates during December and January, consequently there was a better fruiting environment in this rotation. Unfortunately there was no visible difference in height of plants or habit of growth between any of the cotton crops on the different rotations to offer a clue to the cause of this outstanding result and it was not possible to do any systematic soil sampling for moisture or nitrate determinations.

Residual Rotation Trial.—Reports have been received of farmers who planted cotton following potatoes on fertile alluvial loams having obtained very poor yields from rankly grown crops which exhibited every evidence that there had been an excess of nitrates militating

against successful cotton-growing. Accordingly a randomized block experiment embracing cotton, grain sorghum and potatoes was grown in 1941–42 preparatory to planting cotton over all plots in 1942–43. Cotton was planted in all plots in mid-October, 1942, following a storm of 1 inch and when the rows of plants were discernible, a spray irrigation at the rate of 3 acre/inches was applied, after which the crop was grown without further irrigation.

No differences in the growth of the cotton were discernible until after late January when it was apparent that the plants following potatoes had not been affected by the hot dry conditions of that month as much as those after sorghum and cotton. Following the early February rains, the plants after potatoes grew taller and developed more squares than those following the other crops. The difference became increasingly pronounced as the season advanced without any really penetrating rain being experienced to supply additional soil moisture.

Data from 30 plants on each of the plots previously under potatoes and cotton indicated that the plants following potatoes had a mean of 8 large vegetative branches as compared with 6 following cotton ; the mean length of such branches on cotton following potatoes was 24 inches as compared with a range of 15 to 18 inches after cotton, and the mean diameter of the branches at their junction with the main stalks was $\frac{3}{8}$ inch compared with $\frac{1}{4}$ inch. Examinations of the rooting systems after they had been ploughed out to a depth of 6 inches indicated that, after potatoes, the mean diameter of the stalk at both the cotyledons and 6 inches below that point was larger, the large lateral roots were of greater diameter, and the roots were apparently deeper penetrating than were the root systems of cotton following cotton.

The site of the experiment was in the 11th year of cultivation and in a normal season should have contained sufficient nitrates to have produced rank growth following the clean cultivation given potatoes. Unfortunately nitrate determinations were not made until the differences in plant growth became apparent, by which time there was no difference obtained between the small quantities of nitrate present. The leaves of the plants following potatoes were larger and greener and remained longer on the plants than those following the other crops. It is probable, therefore, that more nitrates were absorbed in December and January in the plots following potatoes, but the dry January controlled any tendencies of the plants to make excess growth.

Soil moisture determinations were not made, but it is suspected that in the previous season the shallow-rooted potato crops failed to exhaust, as the cotton and sorghum crops did during the long dry autumn, the copious supply of moisture that was present to $4\frac{1}{2}$ to 5 feet in all areas on the Research Station following the February rains. Consequently the combination of probable additional nitrates present after the potatoes, which were planted in March on an all-summer

fallow and were given several cultivations, and a greater amount of subsoil moisture, enabled the cotton plants following potatoes to withstand the hot dry conditions of January better than did the cotton after both cotton and grain sorghum. The yields of seed cotton per acre obtained were :—following potatoes, 1,035 lb. ; sorghum, 713 lb. ; and cotton, 606 lb. The experiment will be continued, as the seasonal conditions were not typical of those ruling when poor yields of cotton have been obtained following potatoes.

The yield following cotton illustrates the value of the combination of mid-October planting and the seedlings having ample subsoil moisture in which to penetrate, when cotton is grown on old cultivations. This experiment was planted on October 19th, and an adjacent area of the same age of cultivation and fairly similar cropping history was planted on November 9th. The resultant yields were :—October planting, 606 lb. seed cotton per acre ; November planting, 180 lb.

Rhodes Grass–Cotton Rotation.—The investigations into the merits of this rotation were continued along the lines previously reported, in the following experiments :—

E.10–16.—The cotton plots were planted at mid-November on areas ploughed in July when the moisture was sufficient in the surface soils to allow of good ploughing, though below 16 inches the soil approached the permanent wilting point. Moisture determinations were conducted fortnightly in an old cotton cultivation and land in the third year of cotton after three years of Rhodes grass. The rains in December kept the moisture in the top 12 inches of soil at practically field capacity in both treatments, but did not penetrate past 18 inches. During the dry January the plants in the third year after Rhodes grass used the moisture to a greater extent than did the plants in the old cotton cultivation, and by February 4th there was 4 per cent. (absolute) less moisture in the top 18 inches of soil in this area than in the older cultivation. Rainfall, which was of a penetrating type and totalled 3·81 inches during the next fortnight, entered 18 to 20 inches in the grassland–cotton area, but just barely reached the 18-inch depth in the older cultivation. Thence onward the dry conditions mostly prevailing resulted in the plants nearly exhausting the moisture to permanent wilting point to the depth of their root penetration in both areas. Slow and medium rainfall totalling 2·39 inches between May 13th and 19th penetrated to about 10–12 inches in both treatments. At no time during the season was the moisture in the 16–18-inch zone in either treatment at field capacity, while the 22–24-inch zones only contained moisture slightly in excess of permanent wilting point at their highest content. The crops were thus unable to make satisfactory growth during prolonged dry spells.

Nitrate determinations of soil samples taken at the same times as those for soil moisture determinations, indicated that during November the nitrate content in the 3rd year cotton land increased from nil to 9 p.p.m. of soil in the 4–6-inch zone, which was the highest

quantity for the season in this treatment. As practically no nitrates were obtained in the readings for the 16–18- and 22–24-inch zones throughout the season, the plants were apparently dependent on the surface supplies, and by mid-January had almost exhausted the nitrates as evidenced by nil readings in all zones.

In the older cultivation, however, where the nitrate content of the 4–6-inch zone increased from 3 to 20 p.p.m. by December 4th, the plants were not able to exhaust the nitrates of this zone, and by mid-January had only reduced them to 11 p.p.m.—the same quantity as had been present at November 7th. The nitrate contents of the 10–12- and 16–18-inch zones remained fairly constant around 6 to 7 p.p.m. from November to mid-February, thus indicating that little if any leaching of nitrates to those zones occurred during that period, or that the uptake of nitrates by the plants prevented the accumulation of the leachates. As the plants were of a bushy leafy type it is probable that the latter hypothesis is the correct explanation. The nitrate content of the 22–24-inch zone stayed fairly constant around 12 p.p.m. all season excepting early in January when some localized increases occurred due possibly to moisture penetration through cracks in the soil. Apparently little root penetration into this zone occurred in the older cultivation.

The ratio of moisture to nitrates in each soil treatment was reflected in the plant structure developed and the yields produced. The mean height of plant of the Miller and Triumph varieties was respectively 10 and 6·6 cm. higher on the grassland–cotton rotation area, and also both varieties had more fruiting branches and produced greater yields on this area than on the older cultivation.

The areas in which these soil moisture and nitrate determinations were made are a portion of the main experiment in which the merits of growing cotton in the first, second and third year after three years of Rhodes grass following three years of cotton are being tested over a long series of seasons. Unfortunately shortage of staff has prevented the moisture and nitrate determinations from being carried out each season in all three ages of cultivation. Accordingly these studies have been confined to the E.10 and 13 areas during the last three seasons, so that it would be possible to compare E.10 in the 1st, 2nd and 3rd year after Rhodes grass with E.13—land successively cropped with cotton for several years. In all three seasons the permeability of the top 18 inches of soil in E.10 has been better than in E.13. During this period the mean nitrate content at any sampling (8 determinations) of the top 6 inches of soil of E.10 has not exceeded 11 p.p.m., while the lower soils to a depth of 24 inches seldom recorded a mean of 3 p.p.m. The nitrate content of E.13, however, has been, at the peak period, at least 20 p.p.m. in the upper 6 inches of soil in each season, with the subsoils to 24 inches containing as much as 28 p.p.m. at some period of plant growth, except in the 1942–43 season, when apparently no leaching to this zone occurred.

The yields in the companionate areas of first and second year of cotton after grassland have once more shown that on this particular soil type, cotton in the second year after Rhodes grass is ploughed out may be expected to produce better than on the other two ages of cultivation. The yields in lb. seed cotton per acre of each variety in all four treatments are presented to show the effect of treatment on each variety.

	Triumph	*Miller*	*Mean Yield*
E.13—cotton continuously	414	242	328
E.15—1st year after Rhodes grass...	752	341	546
E.14—2nd year after Rhodes grass	800	473	636
E.10—3rd year after Rhodes grass	671	320	495

The effect of treatments on the yields of both varieties, although of different magnitude, is interesting in relation to the time of ploughing under Rhodes grass experiment in I.11–14, reported last season. The residual effect on yield of the different treatments of that experiment was tested this season. Some irregularity of results was obtained, but the comparisons all indicated that the February and June, 1941, ploughed areas appreciably outyielded the August, 1940, ploughing, *i.e.*, land in the third season after ploughing of Rhodes grass, produced less cotton than did land which had been ploughed six and ten months later. Unfortunately it was not possible this season to provide an area of Rhodes grass on which to repeat this investigation of the merits of late summer ploughing of three-year-old established Rhodes grass. In view of the lower yield obtained on the first year cultivation for the three seasons of the investigations in E.10–16, the merit of late summer as compared with mid-winter ploughing of Rhodes grass will be studied extensively in future seasons.

Age of Cultivation Experiment.—Land in the 18th, 14th and 11th years of continuous cotton cultivation out of native grassland, and in the 2nd year of cotton following three years of Rhodes grass following three years of cotton from virgin grassland, was made available for entomological investigations of the merits of different treatments to control corn ear worm. The yields of the untreated control plots in each age of cultivation are used to indicate the relative yielding ability of each age of cultivation under the seasonal conditions experienced. On this basis the 2nd year after Rhodes grass produced at the rate of 448 lb. seed cotton per acre as compared with 180 lb. for the 11th and 14th years and 200 lb. for the 18th year. The series of plots was originally considered to be approximately of equal productivity.

Irrigation Investigations.

The results obtained from the irrigation investigations during the two previous years indicated that mid-October plantings yielded better than crops planted towards the end of that month. Accordingly the pre-planting waterings were arranged this season to allow all of the plantings being completed by mid-October. Unfortunately severe

attacks of different insect pests were experienced which caused heavy loss of terminals, except in the last planting made at mid-month. A malformed type of plant structure resulted which was not as productive as those of previous seasons.

Effects of Supplementary Irrigation.—The site of this experiment was in the third season of cultivation with the respective treatments on the same plots as in the two previous seasons, in order that eventually the residual effects of continuous use of both methods of cotton-growing on a soil can be studied.

The irrigation plots were planted in the first week of October following a 3-inch spray irrigation. The non-irrigation plots were planted after 0·95 inches on November 9th, and required the next rain to establish a suitable experimental stand. The plants on the irrigation plots were thinned to 1 ft. singles when 6–9 inches tall, at the time when the non-irrigation plots were being planted. The latter were thinned on December 7th. Flowering started at this date in the irrigation areas and on January 11th in the non-irrigation areas.

The dry conditions occurring from early November into December presented the problem of deciding whether it was advisable to irrigate while the dry conditions ruled or to wait in the hope that good rains would eliminate the necessity for a watering. In the 1941–42 season this latter procedure was adopted and the continuance of the dry weather until December 20th made it necessary to irrigate, following on which some shedding occurred, the watering having been delayed too long. Although the plants were not checked severely, it was decided to water on December 4th, for it was felt that with the vegetative type of plants developed as a result of the loss of the terminals, later watering followed by good rains would provide an excess of moisture which would promote very rank growth of plant and loss of squares, particularly if the irrigation was delayed too long as in 1941–42.

Unfortunately showery conditions yielding 3·84 inches compared with a previous mean of 3·56 inches for December were experienced over the rest of that month and these, in conjunction with ample nitrates in the surface 6 inches of soil, caused the development of a soft leafy bushy type of plant with extensive vegetative branches. The continued ample moisture present in the upper soils promoted the formation of a shallow type of root system which during a stress period in the latter part of January was unable to supply sufficient moisture to these vegetative plants to maintain them until irrigation could be applied to this portion of the irrigation area. The plants reacted suddenly to the stress conditions of that period and before irrigation could be applied, severe mid-day wilting of leaves accompanied by considerable loss of squares had occurred.

Flower production in the irrigation plots was very slow in December during the period of rank growth of the plants and did not become substantial until the effect of the hot dry conditions ot January

operated. A satisfactory rate of flowering continued from mid-January until February 6th after which flowering declined quickly to practically nil, due to the loss of squares occurring from mid-January onwards.

The plants in the non-irrigation areas experienced considerably less early insect attacks than occurred in the irrigation plots. Counts made in each treatment at 6 weeks after each planting indicated only a 40 per cent. loss of terminals in the rain-grown areas as compared with 70 per cent. in the irrigation areas. It is considered that the later planting of the former and possibly the tougher type of plant resulting from the slower early growth of the seedlings in these plots may account for this substantial difference in terminal loss.

The good rainfall in the second half of December promoted rapid plant growth in the non-irrigation plots, however, and the dry weather in the first half of January was needed to slow up plant growth and to force square formation. At the end of that month prospects of a good yield being obtained from these areas appeared to be excellent until a heavy jassid attack developed. This attack, in conjunction with the continuance of the hot dry weather until February 6th, affected the plants so severely that following the good rains experienced to the middle of that month a drastic shedding of bolls and squares resulted. The plants in the irrigation plots, on the other hand, showed evidence of only a slight attack of jassid having been experienced. These plants, although of a bushy type, were of a tougher growth, while the leaves were of the usual yellowish green colour associated with laden plants on soils of only moderate nitrate content.

Soil moisture determinations made fortnightly through the season provided interesting data illustrating the effects of dry and moist surface soils on the penetration of different rainfalls and also the use of moisture by plants of different ages of growth. Owing to the good rains in May, 1942, there was fair moisture below the dry 7 inches of ploughed surface soil to the 24-inch zone in the plots of both treatments at the date of application of the preplanting irrigation of 3 inches. This watering wetted the upper 2 ft. of soil to field capacity. In the non-irrigation areas, however, although 1·46 inches of rain fell in October, 1·51 inches in November, and 1·96 inches to mid-December, it occurred mostly in groups of light storms in each of these months. It was not until 2·95 inches fell at the end of December and in early January that the upper 2 ft. of soil were wet to field capacity. This latter moisture did not penetrate more than 12 inches in the irrigation plots owing to the rapidly growing bushy plants having dried out the upper foot of soil to a significantly greater extent than had the small plants in the non-irrigation plots. Again, at mid-January 1·65 inches of rain, which was of the torrential (over 0·75 inches per hour) and medium (0·40–0·75 inches per hour) type of rainfall, occurring over 2 days, penetrated the dry hard surface of the irrigation plots to a depth of only 5 inches, as compared with roughly 10 inches in the moister non-irrigation plots. During the first fortnight of February, 3·81 inches of slow to medium types of rainfall penetrated

only 16 inches in the irrigation areas in which the moisture of the top 24 inches of soil had been reduced almost to permanent wilting point, due to the inability to irrigate this area soon enough. In the decidedly wetter non-irrigation areas this rainfall penetrated to 22 inches.

Moisture penetration studies in other portions of the Research Station on soils somewhat similar to the irrigation plots confirmed the findings of poor penetration of storm rains in the dry surface soils of the irrigation plots. In I.11–14, one inch of mostly torrential rain in October penetrated 4 inches in the very dry open surface soil of this area which was in the second and third season after Rhodes grass. In mid-January, when the surface had become fairly smooth and compacted from the late December rainfall and was in a dry condition, 0·90 inches of rainfall, much of which was of a torrential type, penetrated a mean depth of 2·4 inches. In adjacent areas in the third or more seasons after grassland, with well-cultivated surfaces, only an additional inch of penetration was obtained from this storm.

Nitrate determinations were made of soil samples taken in the irrigation and non-irrigation areas. The irrigation plots had a mean reading of 17 p.p.m. in the upper 6 inches of soil on November 4th, but thence onward the nitrate content of both the upper 6 inches and the rest of the soil to a depth of 24 inches rapidly declined until by early March no nitrates could be obtained in the determinations. In the non-irrigation plots, however, the nitrates increased from 18 p.p.m. in November to 29 p.p.m. early in January in the surface 6 inches of soil, and were only reduced to 8 p.p.m. in that zone by early February. The late December rains leached nitrates into the second 6-inch zone of the non-irrigation plots as evidenced by an increase of 6 p.p.m. at the readings of January 4th.

The mean yields obtained from the two treatments were 1,137 lb. and 489 lb. seed cotton per acre in favour of the irrigation areas. The fibres from both treatments were stapled 1 inch in length—with those of the irrigation area tending to be the longer. The lint percentage of the cotton from this treatment was 1·3 per cent. (absolute) greater than that obtained off the non-irrigation plots. The marked reduction in yields of the irrigation plots as compared with the results obtained in the two previous seasons in which no early December irrigation was applied, raises a doubt as to the wisdom of irrigating cotton early in that month irrespective of the season, especially if loss of terminals of the main stalks has been excessive. Based on the previous results obtained in the irrigation investigations at this centre, any checking of plant growth sustained through non-irrigation early in December will probably cause less damage to the ultimate yield than will result if the crop is watered too soon in that month. This applies particularly if showery conditions conducive to rank growth of plant follow soon after this watering, in what is the period of greatest nitrification during the season.

The yields obtained and the moisture and nitrate determinations show clearly the necessity of practising cultural operations in

non-irrigation cotton, and cultural operations and methods of watering in irrigation cotton, which will provide the greatest possible storage of subsoil moisture prior to planting time, and the greatest possible penetration of moisture of each storm experienced or irrigation applied during the growing period of the cotton crops. The nitrate determinations in the non-irrigation plots and the resultant plant growth of the November-planted crop on those areas, clearly illustrate the effect of planting later than October on fertile alluvial soil in the third or more years of cultivation out of grassland.

Triumph Strain Trial.—The results which have been obtained in recent seasons in districts other than the Callide Valley in commercial plantings of the Triumph variety on very fertile alluvial soils have indicated that, owing to its ability to set a crop quickly, this variety may become the leading cotton grown under supplementary irrigation on such soils. Accordingly an 8 strain×4 plot randomized block experiment of this variety was grown on the irrigation area at the Research Station this season to obtain comparable data on their relative suitability for this method of cotton growing.

The experiment was planted early in October and suffered almost total loss of terminals of the main stalk. A very abundant vegetative growth resulted during the showery period in December which tended to give the quickest fruiting strains an advantage over the slower ones. The yields obtained ranged from 1,218 lb. to 1,440 lb. seed cotton per acre, with a mean yield of 1,330 lb. The relative order of merit of the strains was in keeping with previous results obtained in non-irrigation strain tests and in demonstration plots. The selection of the most promising strains for further improvement for growing with supplementary irrigation has thus been simplified.

Spray versus Furrow Irrigation.—The results obtained in this experiment during the previous two seasons indicated that there was apparently no difference in the relative merits of these two methods of irrigating cotton. It was not intended, therefore, to continue this experiment. The area was made available for entomological investigations this season, but through a misunderstanding the pre-planting irrigation was applied as a Student test of the merits of spray *versus* furrow irrigation. The subsequent watering at mid-season was applied in furrows over all plots.

This experiment was the last of the irrigation area to be planted (October 10th–15th) and on November 24th had experienced considerably less terminal loss than had the rest of the experiments planted earlier in this area. The smaller loss of terminals allowed the development of a more normal type of plant in this area which did not make rank growth during the showery periods experienced to mid-December. Consequently with the reduced transpiration there was ample moisture in the upper soils to sustain the plants until their tap roots penetrated well into the moist subsoils. Following the good penetration of the late December rainfall the plants of both treatments

in this area developed a nice type of structure and yet did not require an irrigation until the end of January. In an adjacent area, cotton planted ten days earlier, which had lost most of the terminals of the main stalks and had developed a bushy type of plant following a spray irrigation early in December, exhibited definite signs of stress conditions in late January and had to be irrigated prior to this experiment.

The furrow irrigation at the end of January at the rate of 3 acre/inches provided ample moisture to mature the crop, the final yields—1,360 lb. and 1,214 lb. seed cotton per acre—being significantly in favour of the furrow preplanting irrigation. The combination of later planting and less terminal loss, accompanied by more development of the normal type of plant, brought out the advantage of the deep penetration of the preplanting irrigation obtained with furrowing irrigation. The results, therefore, confirm last season's conclusions that where soil conditions are suitable, the furrowing system has much to commend its use.

Irrigation Varietal Test.—This experiment was continued on the site of the previous season's tests, the land being in the fourth year out of virgin grassland. Following a spray irrigation at the rate of 3 acre/inches, this test was planted on October 2nd. Very severe terminal loss resulted first from attacks by thrips and then *Heliothis* and *Crocidosema*, the final loss being approximately 90 per cent. of the plants remaining after thinning. Flowering did not commence until December 1st and continued lightly until the hot dry period early in January forced a rapid increase in all varieties. A steady decline set in in February, however, and all flowering practically ceased by the 20th of that month.

This area was given a spray irrigation at the rate of 3 acre/inches early in December on the same basis as described in the Effects of Supplementary Irrigation Experiment. The subsequent rainfall, combined with this irrigation, undoubtedly promoted the growth of an excessively bushy type of plant which was very subject to climatic and moisture variations experienced during the rest of the season. Consequently it was necessary to time further irrigations carefully in order to avoid either checking the plants excessively or stimulating further excessive growth. In an endeavour to avoid the latter, watering was withheld in January and not started until February 3rd, when the final 3 acre/inches of spray irrigation was applied.

The resultant yields were very much lower than those obtained in the two previous tests, the mean yield being 1,155 lb. seed cotton per acre. Stoneville led once more, but the smaller boll and the poor quality of the fine-diametred fibre of this variety produced in an irregular season, as compared with both Miller and New Mexican Acala, offsets its slight superiority of yield over these varieties. Miller and New Mexico Acala are therefore being distributed to the irrigation farmers in the Callide Valley and adjacent areas with suitable soil

conditions for these varieties. A new strain of Rowden, 40–6–F.3, was substituted this season for Farm Relief. This strain produces a fuller-bodied cotton than Farm Relief, is quicker-maturing than Miller, and yielded sufficiently well to justify further testing.

Entomology.

Last season's experimental work at the Research Station has confirmed some former conceptions of *Heliothis* behaviour and modified others. The winter of 1942 was relatively mild and favoured pupal survival, a fact amply demonstrated in the field by high moth populations during spring. Data collected on egg-laying and larval populations indicated that egg deposition and moth activity were in no way dependent on plant factors such as the stage of growth, though larval survival and the consequent amount of damage are conditioned by such factors. Rainfall only induces moth emergence when the prior life cycle has reached the pupal stage and the pupæ are then in the ground. Thus rainfall may, under some circumstances, remove the risk of crop loss by destroying moths on the wing before the plants respond to the rains sufficiently to support larvæ.

Of three experiments concerned with testing the efficiency of a 1–1–6 lead arsenate-molasses spray against *Heliothis*, two gave negative results. In one rain-grown block the crop collapsed in mid-season owing to moisture deficiencies at a critical stage in its growth. In an irrigation block, seedling pests produced a rank straggly type of growth which from past experience is unlikely to be favourable for the use of insecticides. The third insecticidal experiment on a non-irrigated crop gave marked yield increases in treatment schedules which ensured the presence of arsenical deposits on the plants when the main outbreak of *Heliothis* occurred. A review of the data from all three experiments adds emphasis to an earlier expressed view that plant type and the efficiency of insecticides for the control of this pest are correlated. The importance of this is also indicated by the fact that the increased yields attributable to insecticides are greatest on relatively new land which normally grows a small to medium-sized fruiting type of plant.

Time-of-planting experiments in which insecticides were not applied all produced yield figures in favour of mid-October sowing, but differences can be ascribed entirely to the relative suitability of the plants for larval development when the main outbreak of *Heliothis* took place.

EXPERIMENTAL PROGRAMME FOR THE SEASON 1943-44.

The proposed programme for 1943–44 embraces the following investigations :—

Plant Breeding.—(*a*) A continuation of the testing of the merits of the various generations of backcrosses of Miller and U.4.

(*b*) Increasing the multiplication of III–26 Miller, improving the uniformity of 41.J and progenies of Miller selections for jassid resistance, and testing the relative yielding ability and quality of the most advanced jassid-resistant strains of Miller.

(*c*) Studying the inheritance of hybrids of Ferguson with the New Mexico Acala and Triumph cottons.

(*d*) Improving the uniformity and quality of the Miller 41.S and 39 and New Mexico Acala strains now grown commercially.

Agronomic and Varietal Experiments.—A continuation of the general programme reported upon for the 1942–43 season with modifications in the experiments relating to both irrigated and non-irrigated cotton, to embody amplifications indicated to be desirable based on the results obtained in this past season.

Entomology.—(*a*) The incidence of *Heliothis* in crops planted at approximately three-weekly intervals.

(*b*) The incidence of *Heliothis* in crops grown on areas with distinct crop histories and its correlation, if any, with the type of plant developed.

(*c*) The efficiency of insecticides during *Heliothis* outbreaks on crops of different ages grown on both irrigation and non-irrigation areas.

SOUTH AFRICA
SEASON 1942-43.
Introductory Note
BY
F. R. PARNELL.

Staff.

Barberton.—The staff was double that of the previous growing season, as we were fortunate in having the services of Mr. H. E. King, of the Sudan Department of Agriculture, and of Mr. Ruston, who was released from Military Service in December.

Swaziland.—The position remained the same as last season, with both Mr. Lochrie and Mr. Hutchinson working under the Administration.

Commercial Crop.

The acreage under cotton and the crop produced were even smaller than in the previous season, and there is little likelihood of improvement in present circumstances. The demand for cotton in the Union has increased, but it is being imported at a low price from other African countries, where the general level of prices for farm produce is much lower than it is in the Union. Thus the price of cotton is low in comparison with other crops and it offers little inducement to the farmer.

Native Cotton.—The same position obtains in Swaziland, where the native is able to make money more easily, at the moment, in other ways than by growing cotton. A big factor here is the very high price of cattle, which has largely removed the only incentive to cotton-growing, shortness of cash.

Experiment Stations.

At Barberton the season was reasonably good, in spite of one month when no effective rain fell, and excellent progress was made in a number of lines of work. These included breeding with hybrid material, microscopic examination of "hairiness," and investigations on the relation between hairiness and jassid-resistance.

Economic factors that cannot be controlled make cotton a doubtful crop for the European in the Low Veld. If the price should return to the relative pre-war level, about 5½d. per lb. over a number of years, there would be no hope of the present type of cotton being produced on a large scale. In spite of the good yields obtainable from the U.4 strain now in cultivation, which gives a readily saleable type of cotton commanding a small premium over American Middling, the cost of production is too high for the above price to be remunerative. Though yields are generally good, they might still be improved, but it is possible that the return could be increased more easily by raising the quality.

A substantial improvement inside the U.4 type, either in yield or quality, cannot be expected and for this reason attention has been

turned to hybridization. The U.4-Cambodia hybrids mentioned in the Report represent a most promising beginning. They give lint of much the same style as that of U.4, but with rather greater length, and their behaviour as regards yield in variety trials in the coming season is awaited with much interest.

The work on " quality " hybrids is an attempt to produce a type thoroughly suited to short-season conditions where jassid is prevalent, which will also give lint of substantially higher quality than can be obtained inside U.4. It has been assumed in the past that our conditions are suitable only for a " bread-and-butter " type of cotton and it is true that introduced types of higher quality have been failures, but in nearly all cases susceptibility to jassid has made them quite unsuitable. The problem of obtaining a high degree of leaf hairiness combined with high quality of lint does not appear to be so difficult as originally anticipated. It remains to be seen whether it will be possible to raise strains combining those characters with important field characters, but the work so far is decidedly promising. If it should meet with a reasonable measure of success it would be of great value, either potential or direct, in several other countries of Africa.

It has been necessary to make a detailed examination of the different types of " hairiness " arising in the hybrid material, as also to investigate their relation to jassid-resistance. On both sides the results are of great interest and it is most satisfactory, from the point of view of practical breeding, that this material shows the same close relationship between hairiness and jassid-resistance as we have always found to exist in plain *hirsutum* material. Although the results suggest most strongly that the nature of the hairy covering has determined the degree of resistance in our material, this does not preclude the possibility of the existence of other forms of resistance.

In Swaziland particular attention continues to be paid to problems of soil treatment and manuring. The most urgent requirement in native agriculture here is to replace the haphazard growing of crops, on whatever piece of land gives the best return for the time being, by a more ordered system that will make the best use of the land available, for the future as well as the present.

COTTON EXPERIMENT STATION, BARBERTON. PROGRESS REPORT FOR THE SEASON 1942-43

BY

D. MacDONALD, D. F. RUSTON AND H. E. KING.

INTRODUCTION.

During the past season a largely increased programme of work, as compared with the two previous seasons, was successfully carried through, this being made possible by the increased staff.

Apart from one variety trial of pure U.4 strains, the main breeding work was confined to hybrid material bred during previous seasons. Jassids were present in sufficient numbers to enable investigations into the relationship between different types of hairiness and jassid resistance to be carried out satisfactorily, although the commercial crop suffered no damage. Stainers were comparatively numerous from quite early in the season, but the incidence of internal boll disease was low, the main damage being confined to the seed. American bollworm damage was rather severe in the early flowering period on parts of the breeding block, but no second generation damage occurred. Aphis attack during a drought in January and early February was heavy and, in addition to retarding plant development, made accurate hair classification on stem and leaf in the field extremely difficult for a time.

METEOROLOGY.

The total rainfall, 33·60 inches for the season, was well above the mean for the area. Good spring rains enabled ploughing to be done and seed beds to be prepared early, so that the main cotton planting on the Station was finished by November 10th. Moisture conditions remained good until January, but temperatures were rather low during November and December and tended to retard plant growth. A dry period during late January and February was followed by heavy rains in March, and over 7 inches in April, which probably encouraged the rapid spread of *Alternaria*, with consequent leaf shedding and early closing down of the crop, which occurred in parts of the breeding material.

GENETICS AND BREEDING.

Variety Trial.—Only one variety trial was carried out, comparing eleven of the most recent U.4 derivatives with 5143, the standard strain grown in the area. Initial stand and growth were good, but heavy aphis attack during January and February, followed by the early onset of *Alternaria*, resulted in poor yields ranging from 193 to 271 lb. lint per acre. Two strains which had previously done well, from the old 920 and 921 families, again significantly outyielded 5143. Further testing in more normal conditions is still required, however, particularly against the very promising new strains from the U.4-Cambodia crosses. A large variety trial for this purpose has been planted for the coming season.

Hybridization.

During the past three seasons the major portion of the breeding work carried out on the Station has been concerned with hybrid material. The objects of this work, having been explained in previous reports, need not be recapitulated.

U.4, 5143 × Cambodia.—A total of 143 single-plant selections and 66 special bulks of this cross, carried forward from the previous season, were planted in 4 to 8-row plots along with their parents on a 10-acre block. Field observations during the season showed that a large majority of the lots combined a degree of hairiness greater than the

hairy Cambodia parent with field characters equal to, and in some cases better than, the U.4 parent.

No single-plant selections were made during the season as it was felt that further re-selection might lead towards over-specialization of types suitable for these local conditions only. Instead, large bulks were taken from the progeny plots, covering a wide range of types, all of which, on this and previous seasons' records, possessed the required combination of hairs and economic characters. Table I gives the analysis of the best bulk of those carried forward, along with the mean figures for the best 16 lots. In this table also are included the mean figures for 55 single-plant selections carried forward from the F_3 of M.U.8×8161 described in the following section.

TABLE I.

U.4×Cambodia and M.U.8.

	Yield per Plant, grms.	*Ginning %*	*Seed Weight.*	*Lint Length, mm.*	*Range of Hair Grades.*
C.×5143, best bulk	—	37·3	12·1	34·8	2
Do. mean of 16 bulks ...	—	36·7	10·5	33·3	3+ to 1
M.U.8×8161, F_3, mean of 55 Single Plants	138	36·1	9·5	33·9	3+ to 1
Standard 5143...	—	35·6	9·0	31·0	3

The figures for the Cambodia crosses show, for the third successive season, a combination of ginning percentage, lint length and hair grade far superior to either parent. While the range of hair grades is shown as 3+ to 1, only one progeny had plants in it graded as low as 3+, the grade of Cambodia, while 6 out of the 16 lots were graded 2+ or better.

These 16 bulks, along with a further 14 out of the total of 34 bulks being carried forward, will be tested for yield along with the best U.4 strains in variety trials during the coming season, at both Barberton and Swaziland Stations. Seed from a few of the above bulks has been sent to S. Rhodesia, Nyasaland, Tanganyika and the Belgian Congo for observation next season.

U.4×M.U.8.—A total of 271 single-plant selections were grown, along with the back-cross bulks of the three U.4 parents, 8161, 8171 and 8202, used in the original cross. As in the previous season, it was very easy to find high-yielding plants with good hairs, but it was extremely difficult to get this combined with good lint characters, the short harsh lint of the M.U.8 parent predominating. This was specially true of the M.U.8×8171 and M.U.8×8202 lots, where no good linted types could be found, and the progeny of both these crosses has now been discarded entirely.

In the M.U.8×8161 lots it was possible to find plants with the required combination. Mean figures for the 55 single plants carried forward (*see* Table I) show that, although the range of hair grade is

lower than the hairy M.U.8 parent, the lint characters are decidedly better than either parent. In addition to these single plants, 13 large special bulks are being carried forward for further re-selection and for yield tests against the best U.4 and U.4×Cambodia types next season.

Quality Crosses.

The main object of this series of crosses is an attempt to obtain types possessing good field characters and a high degree of hairiness with better quality lint than it is possible to obtain directly within the U.4 family. The main hairy parents used have been U.4 and M.U.8 and they have been crossed with the finest linted *hirsutums* available, Coker Wild's, Tidewater, Meade and Uganda B.P.52, as well as with Sea Island and Egyptian strains.

U.4 and M.U.8×Coker Wild's.—F_2's and backcrosses to both parents covered a two-acre block. Unlike the U.4×Cambodia material, where plants with better hairs and lint than either parent were common, no such complementary effect was present in these crosses, the best hair grade and lint length being about equal to or slightly under that of the better parent. In the U.4×Coker F_2 it was possible to find a small number of plants as hairy as U.4 with lint approaching that of Coker in length and fineness. More easily found were plants combining good general characters with hairs and lint a little inferior to the better parent.

In the M.U.8×Coker F_2 more difficulty was experienced in finding really hairy plants with lint approaching the Coker quality, but in the backcross to Coker, plants with good lint and hairs were commoner.

Several rows of both the above F_2's were classified for hair grade in the field and a slight negative correlation with lint length was found in both cases. In the U.4×Coker, $r = -\cdot 2167$, while in M.U.8×Coker, $r = -\cdot 1917$, significant at $P = \cdot 05$ in both cases. From both the above crosses a total of 94 single plants and a few bulks are being carried forward.

B.P.52.—In Uganda B.P.52 we have the best combination of good hairs and quality lint so far used as a parent. Hair grades within the strain range from 3+ to 6, the better hair grades predominating, while lint lengths also show a considerable variation of from 32 to 36 mm. Although a negative correlation between hair grade and lint length of $r = -\cdot 2920$ (significant at $P = \cdot 01$) has been obtained, it has been possible to find many of the more hairy plants possessing excellent lint. On the other hand, the ginning percentage is low, and the field characters of the strain in general are not satisfactory in short-season conditions. 100 single plants, all combining good hairs and lint length, along with as good field characters as it was possible to obtain, are being carried forward in order to obtain the best strain it will give for use as a parent in this work.

U.4 and M.U.8×B.P.52.—F_1's of these crosses were back-crossed by hairy B.P.52 plants this season and sufficient seed is available to plant large plots of these backcrosses in addition to F_2 in the coming season.

In addition, advantage has been taken of the combination of lint and hairs in B.P.52 to use this type for back-crossing a number of other quality crosses. This should result in improving the standard of lint without seriously reducing hairiness in the material generally, thus increasing the scope of future selection work.

U.4, 8161×Sea Island and Egyptian.—From these crosses a total of 170 single-plant selections, mainly from the F_2's, together with special bulks from the back-crosses to 8161, were planted over about 7 acres. As expected, they exhibited a very wide range of variation in many characters, including lint length and hairiness. Full details of the great diversity of hair types are given in a later section dealing with Hairiness and Jassid-resistance. It may be noted here that, of the many new types that differed widely from both parents, some showed a very high degree of hairiness, either of the whole plant or of the leaf only.

Although the bulk of the material was useless from an economic point of view, there was sufficient to give many plants possessing a desirable combination of characters. This applied mainly to single plants, but one family giving a substantially uniform lint length, averaging 38 mm., contained a large proportion of plants with much better leaf hairs than the U.4 parent.

Whilst the tendency of long fine lint to be associated with less hairy plants exists in the material, the correlation is not appreciable and no difficulty was experienced in finding very long lint combined with an excellent degree of hairiness. A large number of economic selections was made of plants showing the above combination in association with good general field characters. Of 287 final selections to be carried forward, about two-thirds gave lint lengths of 36–43 mm., and the general standard of hairiness was better than that of U.4.

Plant Hairiness.

Great attention has always been paid to the relative hairiness of cotton strains handled at Barberton. A system of comparative grades, developed for use in comparing varieties of *G. hirsutum*, has been described in previous reports. The grades used in this system were based on hairiness of the plant body as a whole, but using the main stem as the chief criterion in field work. The extension of the breeding programme to cover hybrid material derived from *G. hirsutum×G. barbadense*, has necessitated the employment of other methods of determination and description, since this material not only includes much shorter and denser hairs than have been found in *hirsutum*, but also examples of leaf hairiness differing very conspicuously from that of the stem.

Last year's report gave some preliminary results of the microscopic examination of hairiness, of petiole only, in a number of types. This work has been very considerably extended and improved in the season under report and some of the principal results are given below.

Methods Used for Microscopic Examination.

Leaf Lamina.—Narrow strips, $\frac{1}{2}$ to $\frac{3}{4}$ mm. wide, were cut from the lamina in a standard position near the base of the terminal lobe, avoiding the larger veins. The strips were mounted on edge and the hairs on the underside counted and measured with an eyepiece micrometer, the individual hairs of a bunch being treated as separate hairs for both purposes.

Midrib, Petiole and Stem.—Sections were cut with a hand microtome and the hairs examined in profile. Sections from the midrib were taken between the nectary and the petiole, counts being made on the under surface only. Sections from the petiole and internode were taken from the central portion of each.

Except in the case of the Sea Island × U.4 crosses referred to later, a standard leaf was taken, *viz.* :—the first fully-grown leaf of normal colour below the growing point. The internode immediately below this was the standard for the stem.

Hairiness and Plant Development.

Standard leaves from various strains were examined at different dates, to obtain a record of any variations in hairiness that might take place throughout the season. Figures for various measurements on 5143 and M.U.8, at three dates through the main flowering season, are given in Table II.

TABLE II.

VARIATION IN LEAF HAIRINESS THROUGH THE SEASON.

Strain and Date.	*Midrib Length, cms.*	*Lamina Hairs (Underside).*			*Midrib Hairs (Underside).*				
		Density per Sq. mm.	*Length, mm.*	*Av. No. Hairs per Bunch.**	*Density per Sq. mm.*	*Length, mm.*	*Av. No. Hairs per Bunch.*	*Per 1% Midrib Length.*	
								Hairs.	*Bunches.*
5143.									
Jan. 23	10·9	3·1	·59	2·1	10·1	·82	1·6	27	17
Feb. 12	9·3	4·9	·51	2·3	18·0	·76	1·8	34	19
Mar. 8	8·2	6·0	·44	2·6	20·4	·67	2·2	35	16
M.U.8.									
Jan. 23	12·4	5·6	1·02	1·8	14·6	1·38	1·2	47	39
Feb. 12	10·5	7·1	·87	1·9	19·9	1·24	1·3	51	39
Mar. 8	9·2	7·6	·68	1·9	27·9	1·16	1·4	57	41

*By a bunch is meant a single hair or group of two or more, coming from the same base.

The figures for both lamina and midrib show a steady increase in density of hairs and reduction in length as the leaf size decreased during the period. Number of hairs per bunch increased in both strains, but to only a small extent in M.U.8, which normally carries a large proportion of single hairs.

The increase in density on smaller leaves appears to depend on two factors :—(1) A smaller expansion of the young leaf on which the hairs are already formed, thus leaving them closer together.

(2) The increase in the number of hairs per bunch. This is seen from the last two columns for midrib, where " expansion " is eliminated by taking 1% of the midrib length. Here total hairs still show an increase, though much smaller than that for density, whereas total bunches remain approximately steady.

The increase in number of hairs per bunch with decreasing vegetative vigour is rather surprising. The decrease in length is more understandable, as is also the normal experience that, in any one type or plant, the greater the number of hairs per bunch the shorter they become.

These results were confirmed by figures obtained from B.P.52, of which successive leaves down the main stem were examined separately on six plants. The upper leaves were smaller and carried denser and shorter hairs, with a higher average number of hairs per bunch, than those of the older and larger leaves lower down the stem. Similar figures were obtained for midrib, petiole and stem.

In a small trial with manured and unmanured plants, there was evidence that manuring increased the leaf size and made the hairs longer and less dense, with a smaller number per bunch.

Analysis of " Hairiness " in a Range of Types.

The hairiness of stem, petiole, midrib and leaf lamina has been examined in a wide range of *hirsutum* types, including the greatest extremes seen on the Station, and also in several *barbadense* varieties and some crosses. The results for a selection of these types are given in Table III. Field grades for hairiness are given in addition to density and length of hairs, the date of examination also being noted in view of the changes through the season shown above.

Examination of the table reveals that, although the midrib gave almost invariably the highest density of the parts examined, there was no constant relationship in this respect between the different parts, even in *hirsutum* types. Of the *barbadense* varieties, Sea Island and Egyptian show no relation whatever between stem and leaf hairiness and their crosses combine very hairy leaves with almost glabrous stems.

Length of hair behaved much more regularly than density, increasing substantially in all the *hirsutum* types from lamina to midrib and again to petiole. The average length on the stem was usually slightly greater than on the petiole, due to a greater proportion of single hairs, but the longest single hairs were usually found on the petiole. In the *barbadense* types, on the other hand, length was greater on the lamina than on the midrib, but the crosses showed the reverse, thus following their *hirsutum* parent.

It is clear that grading in the field has been markedly influenced by length of hair as well as by density.

TABLE III.
HAIRINESS IN DIFFERENT PARTS OF THE PLANT IN A RANGE OF TYPES.

Strain.	Stem.		Petiole.		Midrib (Underside).		Lamina (Underside).			Date of Examination.	Field Grade.
	Density per sq. mm.	Length, mm.	Density per sq. mm.	Length, mm.	Density per sq. mm.	Length, mm.	Density per sq. mm.	Length, mm.	Av. No. Hairs per Bunch.		
Acala	—	—	—	—	0·9	·86	0·3	·62	2·1	Jan. 27	6
Coker Wilds	2·5	1·20	0·5	1·35	2·8	·66	0·9	·59	2·2	Feb. 1	6
Meade	0·6	1·21	0·5	1·09	1·7	·67	1·7	·60	2·4	Jan. 28	6
U.4/5143	—	—	—	—	10·9	·89	3·1	·59	2·1	Jan. 23	3
U.4/8161	9·3	·96	6·9	·82	30·6	·56	6·2	·42	3·4	Mar. 17	3
U.4/5143	7·1	1·03	6·8	·84	23·0	·67	6·6	·45	3·2	Mar. 18	3
*B.P.52, Hairy	4·3	1·80	4·6	1·84	17·8	1·06	5·9	·66	2·0	Mar. 12	3+
*B.P.52, Less Hairy	0·9	1·52	1·0	1·40	4·5	·89	3·8	·51	2·7	Mar. 13	6 to 5
*C.9363, Cambodia	5·0	1·50	5·9	1·41	15·0	·90	7·3	·60	2·3	Mar. 10	3+
*P.43 F	5·0	1·66	4·3	1·56	12·4	1·20	4·7	·64	2·6	Mar. 15	3+ to 2
M.U.8	11·6	1·79	7·0	1·72	19·3	1·13	6·5	·73	1·9	Mar. 8	1 to 0
BA 1–1, Sea Island	Nil	—	Nil	—	0·01	·31	2·0	·40	4·0	Feb. 4	—
1730, Egyptian	Nil	—	Trace	—	5·9	·42	6·2	·47	5·6	Feb. 5	—
Tanguis	54·8	·43	32·8	·48	87·2	·38	50·8	·46	7·2	Mar. 22	—
5143×1730	Trace	—	1·6	·65	20·6	·41	9·5	·37	4·0	Mar. 15	—
M.U.8×1730	0·8	·83	2·7	·92	27·4	·59	10·2	·47	3·3	Mar. 15	—
M.U.8×BA 1–1	Extreme Trace	—	Trace	—	14·8	·52	11·0	·49	2·9	Mar. 4	—

N.B.—All 6-plant means except M.U.8=4; Tanguis=1.

* These strains were planted late and had been watered and were consequently more flourishing vegetatively than the others.

Hairiness in G. hursutum×G. barbadense *Material.*

Reference was made in last reason's report to the wide range in hairiness occurring in the F_2's of a U.4 strain crossed with Sea Island and Egyptian. A large number of F_3 families, covering about six acres, showed the two crosses to be giving very similar results this season.

Range of Hairiness.—Microscopic examination was carried out almost entirely on leaf lamina, three typical leaves of normal size being taken at random from each plant concerned.

An immense range was found, both in density and average length of hairs, the former varying continuously from 0 to 34·9 per sq. mm. and the latter from 0·26 to 0·87 mm. Fig. 2, shown later in illustration of correlation of hairiness with jassid attack, gives a good idea of the range in density and length of hairs on a large number of single plants. In general, the denser hairs tended to be shorter, the correlation coefficient for 72 plants being −·424 2, a very highly significant figure. In spite of this, some very good combinations of high density and long hairs were found, *vide* the figures below for the four best of these compared with the hairy parent, U.4, 8161.

	Four F_3 Plants.				*U.4/8161.*
Density per sq. mm.	11·1	12·7	18·6	25·6	6·2
Average Length, mm.	0·80	0·79	0·59	0·52	0·42

Hairs on the stem varied in much the same manner for both density and length, with apparently a similar negative correlation, though this was not tested. The hairiest stems of the *hirsutum* type were equivalent to grade 1, again vastly more hairy than the U.4 parent. All hairy-stemmed plants carried hairy leaves, but the reverse did not apply, as will be seen from the following figures for two plants with very hairy leaves on an almost glabrous stem.

	Stem.	*Leaf Lamina.*	
	Density per sq. mm.	*Density per sq. mm.*	*Length, mm.*
A 2368/17	0·60	14·9	·61
A 2404/30	0·45	10·9	·60

Inheritance.—From the above results it is clear that the inheritance of "hairiness" is decidedly complex. In segregation, density and length, each show, in effect, a continuous range of variation, with one to a considerable extent independent of the other. In spite of the tendency for the higher densities to be associated with shorter lengths, combinations of fair density and good length are quite numerous.

Microscopic examination of whole progenies would appear necessary for a critical study of the genetic basis, but it was hoped that examination in the field of large numbers of plants would reveal some simple ratios resulting from major gene effects. Accordingly,

over 100 progenies, averaging 70 plants each, were classified in various ways for degree of hairiness of stem and leaf. The results were disappointing. Even considering only such broad distinctions as " non-hairy " and " hairy," the numbers in classes rarely gave clear-cut ratios. One progeny only was found apparently pure breeding for marked hairiness of stem, petiole and leaf, and one for hairy leaf on substantially non-hairy stem.

The material planted for the coming season should throw more light on this question. The bulk of it is for economic purposes, but certain parents exhibiting particular types of hairiness have also been included.

HAIRINESS AND JASSID-RESISTANCE.

All previous experience at Barberton has indicated an extremely well marked relationship between hairiness of plant and resistance to jassid attack.* This relationship has, indeed, been so consistent that, in breeding work with varieties of *G. hirsutum*, it has been possible to rely almost entirely on field judgment of plant hairiness for the production of jassid-resistant strains.

With the new types of hairiness shown by the hybrid material now in hand, however, it appeared desirable to investigate this relationship in detail, and in particular to determine the jassid-resistance of plants carrying hairy leaves on non-hairy stems.

The work carried out this season falls into two divisions : firstly, the relationship between jassid infestation and hairiness *as estimated in the field*, where large numbers of plants could be examined, and secondly, the relation between jassid population and the density and length of leaf hairs *as determined by microscopic examination*, using much smaller numbers of plants.

Jassid Resistance in Relation to Field Classification for Hairiness.

For this investigation a large number of plants were chosen early in the season, from F_3 families of the U.4×Sea Island and Egyptian material, to cover a wide range of types of hairiness. Weekly counts of jassid nymphs on three leaves per plant were then carried out over a period of sixteen weeks. At a convenient date, before jassid damage was generally severe, each plant was classified for hairiness of stem and leaf and, in addition, given a mark for *jassid effect* (viz., for the relative severity of symptoms of jassid attack on the foliage).

The results, as regards leaf hairiness only, are summarized in Table IV and Fig. 1. The numbers of jassid are throughout expressed as total nymphs per ten leaves of a standard size (*i.e.*, the actual counts, on leaves from plants of varying leaf size, were adjusted to a standard area of approximately 80 sq. cm. per leaf). The leaf classification was based on an estimate of general " hairiness " of the lower surface of the leaf, without attempting to differentiate between

* See all previous annual reports and in particular that for 1925/26 season.

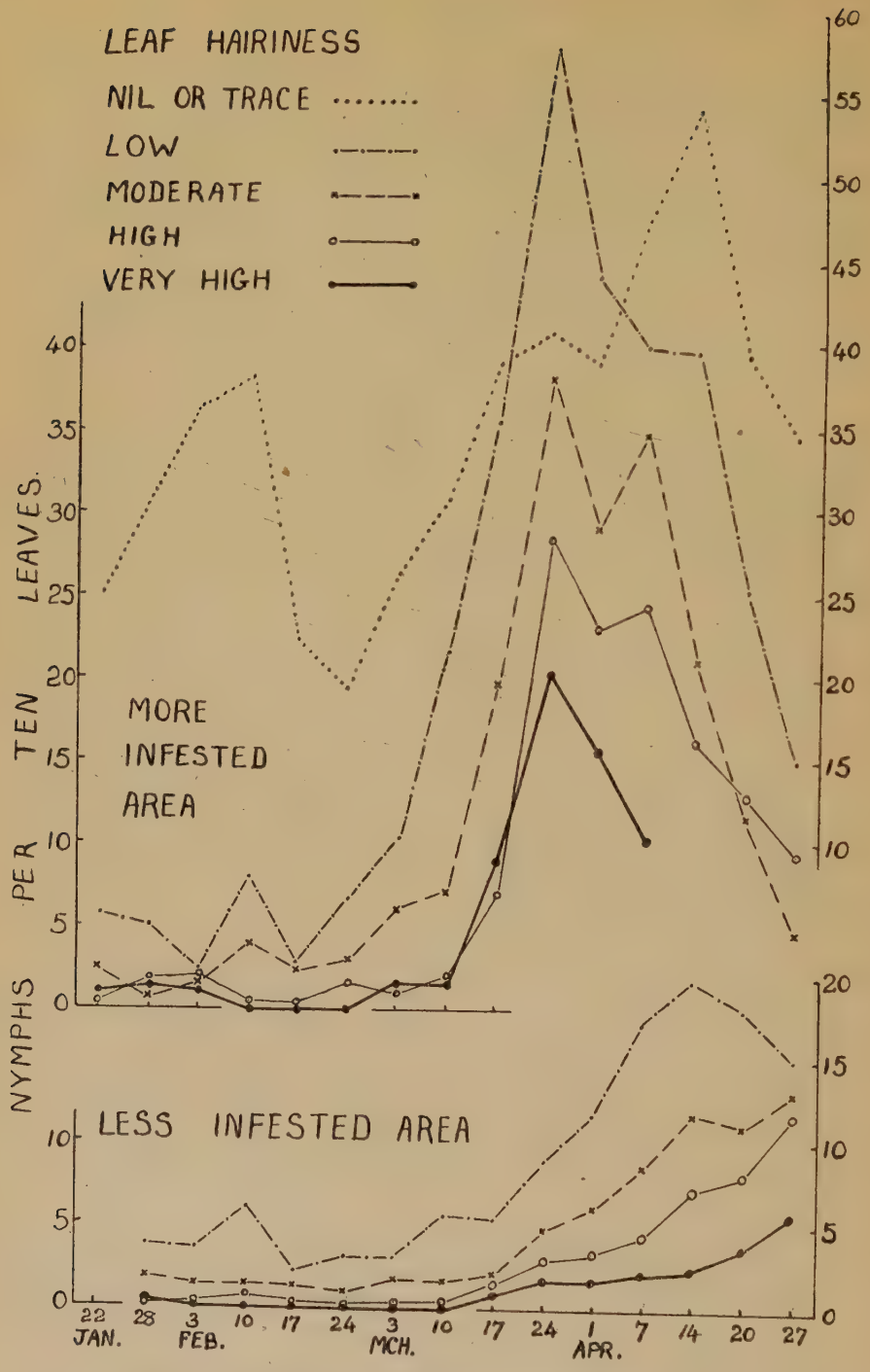

Fig. 1. Jassid Infestation and Field Classification for Leaf Hairiness.

density and length of hairs. A very approximate guide to the meaning, on the average, of a particular field description, is given by the figures (included in the table) representing the average density and length determined microscopically on a few specimen plants.

The plants selected for jassid counting were scattered throughout a number of fields and a proportion fell in one particular area containing a high percentage of non-hairy plants. From early in the season this area showed a mugh higher general level of infestation and the results are therefore subdivided, in both the table and the figure, to present separately the data from a " more infested " and a " less infested " area.

It will be seen from these results that, in both areas, a close and consistent relationship appears between degree of leaf hairiness and numbers of jassid nymphs, while the average mark for " jassid effect " agrees very well indeed with the jassid population figures. It is thus clear that in this material (as with *G. hirsutum* strains) it is possible to obtain jassid-resistance by selecting in the field on a basis of hairiness.

The results obtained by classifying the plants according to *stem* hairiness are not presented. All plants with hairy stems showed resistance, but, since in every case the leaf also was hairy, it was not possible to determine whether any connection existed between stem hairs and jassid in the absence of leaf hairs. Comparison of plants of apparently similar leaf hairiness, with and without appreciable stem hairs, indicated that any added resistance associated with hairiness of stem was at most of very minor importance.

The contrast between the results from the two areas is enlightening. Early in the season hairy leaves of the same description did not differ markedly in infestation, whether or not they were adjacent to numerous non-hairy plants already carrying a large number of nymphs. Later, however, all classes of leaf showed a rapid rise in the former case, contrasted with a slower and much smaller rise in the latter. The presence or absence of this apparent " bombardment effect " has not, however, influenced substantially the relative level of the various classes.

TABLE IV.
JASSID INFESTATION AND FIELD CLASSIFICATION FOR LEAF HAIRINESS.

Broad Class for Apparent Hairiness of Leaf.	*Average Jassid Population and Average Mark for Jassid Effect on Foliage.*						*Hair Counts and Measurements on Specimen Plants.*		
	More Infested Area.			*Less Infested Area.*					
	No. of Plants in Class.	*Nymphs.†*	*Effect.**	*No. of Plants in Class.*	*Nymphs†.*	*Effect.**	*No. of Plants Examined.*	*Av. No. of Hairs per Sq. mm.*	*Av. Length, mms.*
Nil	18	313	6·3	—	—	—	4	0·2	—
Trace	16	333	5·9	—	—	—	3	2·9	0·32
Low	9	195	4·7	23	53	2·6	8	4·3	0·53
Moderate ...	13	111	3·9	82	24	1·8	14	6·8	0·52
High	13	67	2·5	87	11	1·2	19	10·9	0·54
Very High ...	5	52	2·2	36	5	0·9	12	11·7	0·62

† Nymphs per ten leaves, totals of ten weekly counts, Jan. 28 to April 1, adjusted to a standard leaf size of 80 sq. cms.

* Figures obtained by giving numerical values to the field judgment, thus :—Very Slight Effect, 1 ; Slight Effect, 2 ; Obvious Effect, 3 ; Very Slight Damage, 4 ; Slight Damage, 5 ; Moderate Damage, 6 ; Rather Bad Damage, 7 ; Bad Damage, 8.

In view of the surprisingly close relationship found between counts of jassid nymphs and an independent estimate of " jassid

effect " on the foliage, it was possible to utilize further material on which no actual counts of jassid had been made, but for which a more detailed leaf description was available. With these further plants the field description represented an attempt to estimate and record the *density* and *length* of the hairs separately. This differentiation, by the use of a hand lens only, was far from accurate but, on the average, resulted in the effective separation of broad classes. Some indication of the meaning of these classes is again provided by reference to the microscopic determination on specimen plants. Jassid effect was estimated as in Table IV, but later in the season when the symptoms were more severe. All plants were in the " less infested area " of Table 4.

The figures, given in Table V, confirm those of Table IV in relating jassid damage with degree of hairiness. The range from a trace of very short hairs to a high density of long, is associated with a range from " rather bad damage " to something less than " trace." Moreover, throughout the table, *each successive increase in either density or length* of hairs is accompanied by a drop in the figure for jassid effect.

TABLE V.

JASSID EFFECT ON PLANTS CLASSIFIED IN THE FIELD FOR APPARENT DENSITY AND LENGTH OF LEAF HAIRS SEPARATELY.

Classes for Apparent Density of Hairs.	*Classes for Apparent Length of Hairs.*								*Mean Jassid Effect, all Length Classes.*	*Av. Hairs per Sq. mm. on Leaves of Specimen Plants.*
	Very Short.		*Short.*		*Normal.*		*Long.*			
	No. of Plants.	*Av. Effect.**	*No. of Plants.*	*Av. Effect.**	*No. of Plants.*	*Av. Effect.**	*No. of Plants.*	*Av. Effect.**		
Trace...	2	7·0	—	—	19	5·5	—	—	—	—
Very Low Density ...	9	5·7	13	5·2	19	4·4	8	2·8	4·5	3·8
Low Density ...	22	4·7	39	4·5	31	3·3	13	1·6	3·5	7·6
Dense	47	3·6	77	3·2	41	1·5	11	0·5	2·2	10·1
Very Dense	19	2·6	29	1·8	22	0·9	12	0·3	1·4	13·1
Mean Jassid Effect, all Density Classes	4·2		3·7		2·5		1·3		2·9	
Av. Hair Length in mms. of Specimen Plants examined microscopically ...	0·42		0·51		0·55		0·70			

* See footnote of Table IV.

Jassid Resistance in Relation to Microscopic Analysis of Leaf Hairiness.

G. hirsutum Strains.—Jassid counts were made at weekly intervals on some of the strains from which standard leaves were taken for hair counts. Table VI shows the relationship between the jassid counts and the density and length of hairs on the underside of the leaf lamina.

TABLE VI.

JASSID INFESTATION AND MICROSCOPIC ANALYSIS OF LEAF HAIRINESS ON A RANGE OF TYPES.

Strain.	*Jassid Nymphs per 10 Leaves. Total of 12 Weekly Counts.*	*Hairiness of Leaf Lamina.*		*Date of Examination.*
		Density per sq. mm.	*Average Length, mm.*	
D. Block.				
M.U.8	2	6·5	0·73	Mar. 8
B.P.52 Hairy	12	5·9	0·66	„ 12
M.U.8 × Meade	13	5·1	0·60	„ 11
B.P.52 Less Hairy	66	3·8	0·51	„ 13
5143 × Meade	69	2·6	0·48	„ 11
B. Block.				
M.U.8	1	5·6	1·02	Jan. 23
5143	22	3·1	0·59	„ 23
Coker Wilds	384	0·9	0·59	Feb. 1
Acala	427	0·3	0·62	Jan. 27

In these figures a progressive drop in length and density of hairs on the lamina is associated with a big increase in numbers of jassid. The figures are not suitable for determining the relative importance of length and density in this respect, but the vast difference in resistance between 5143 and Coker Wild's is clearly connected with a big difference in density.

G. hirsutum × *G. barbadense*, F_3, *Single Plants.*—Three leaves from each of 72 plants in this material were examined under the microscope. All the plants were from the " less infested area " referred to previously. In Table VII, these plants have been divided into six groups, according to numbers of jassid, the counts being first converted for leaf size.

TABLE VII.

MICROSCOPIC ANALYSIS OF LEAF HAIRINESS ON SINGLE PLANTS GROUPED ACCORDING TO JASSID INFESTATION:

Total Nymphs per 10 Leaves.†		*Average Jassid Effect.**	*Average Hairiness on Leaf Lamina.*		*No. of Plants in Group.*
Group.	*Average.*		*Density per sq. mm.*	*Length, mm.*	
0 – 5	2	0·36	9·1	0·64	11
6 – 23	14	1·06	10·6	0·55	16
24 – 53	38	1·54	15·7	0·50	13
54 – 95	82	2·40	12·3	0·45	10
96–149	110	3·20	14·9	0·40	10
150 and over	247	4·33	10·7	0·37	12

† Totals of 10 weekly counts, Feb. 17 to April 20, adjusted to a standard leaf size of 80 sq. cms.

* *Vide* footnote of Table IV.

In this material it is evident that length is the component of hairiness most closely related to the variations in jassid-resistance. The straight correlation between hair length and number of jassid, for the 72 plants taken separately, gave a coefficient of —·7453, a high and very significant figure.

The apparent lack of connection between density and resistance may be attributed to two causes. In the first place, the plants as a whole gave very high densities as compared with the *hirsutum* types of Table VI, *i.e.*, the density was generally great enough to expect high resistance where length was satisfactory. In the second place density and length were negatively correlated in these plants, as already noted. That density was actually connected with resistance is shown by the *partial* correlation for density and number of jassid, with length held constant, of —·3541. Though much smaller than the figure for length, this is highly significant.

On the diagram given in Fig. 2 (p. 32), each individual plant is plotted for density and length, and the jassid group in which it falls is also indicated. The closeness of the relationship between jassid and length of hairs is manifest, but some connection with density can also be seen.

General Conclusions.—From all the above results, whether based on field classification or microscopic examination of hairs, on actual counts of jassid infestation or on field classification of " jassid effect," it is abundantly evident that a very close connection exists between hairiness of leaf and jassid-resistance. Taken in conjunction with

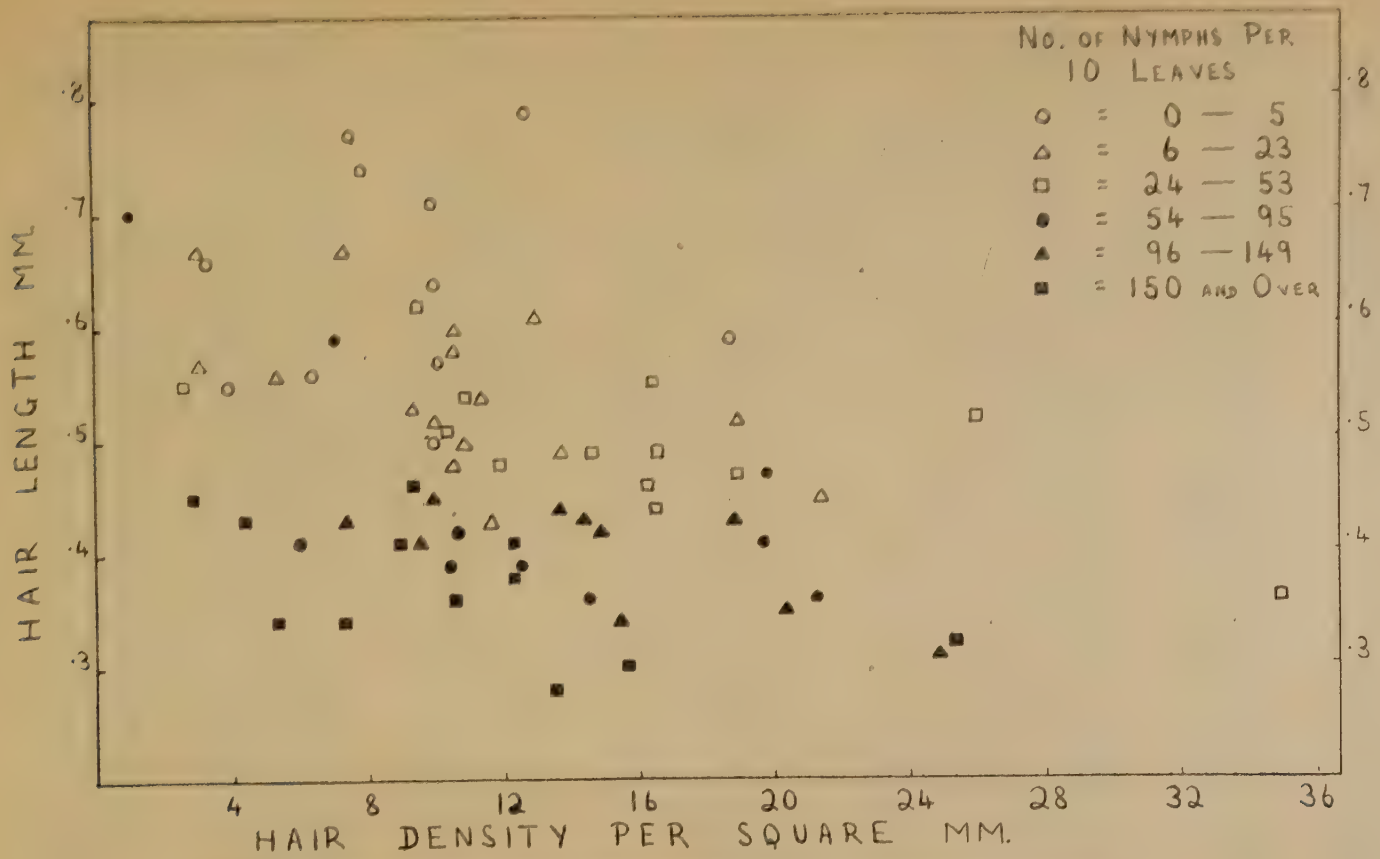

Fig. 2. Jassid populations, totals of 10 weekly counts, on 72 single plnast differing over a wide range in leaf hairiness.

further data not presented, and with all previous experience at this station, it is difficult to avoid the conclusion that this connection is the simple one of cause and effect, with a suitable combination of density and length serving to protect the plant in some manner yet to be determined. Data concerning bendiness, erectness and stiffness of hairs are at present inadequate and present difficulties in analysis, but it is not improbable that such factors also enter into the problem of assessing "hairiness" from this point of view.

Much further work is clearly needed, but it is hoped that experiments planned for the coming season will throw light on a number of these points.

EXPERIMENTS.

Spinning Quality.—Spinning test results are now available on lint samples from four related strains grown both at Barberton and at Domira Bay in the previous season. The strains were Barberton 920 and its derivative 0262, with the same 920 after cultivation for a number of years at Domira Bay and a derivative raised there.

All four strains gave approximately equal spinning values when grown at the same place, but the lint grown at Barberton was clearly superior to that from Domira Bay, vide the figures below.

Lea-Count / Strength at 40's.

Barberton Lint	... Range, 2,180–2,221 ;	Mean, 2,197
Domira Bay Lint	... Range, 1,833–1,889 ;	Mean, 1,870

Soil Structure.—This subject arose in discussions with Dr. W. S. Martin, of the Kawanda Agricultural Research Station, Uganda, on possible reasons for the prevalence of *Alternaria* at Barberton and the debility of the plant that this implies. He very kindly carried out estimates of "crumb structure" on certain soil samples from the station and his results are of great interest. Eight pairs of samples from the periphery of the cultivated area on the red loam were examined, one of each pair coming from the cultivated land inside, 55 years in cultivation, and one from the grass camp outside the fence. The figures below show the great difference in structure between the two sets of samples and indicate a considerable breaking-down of the "crumb" in the cultivated soil.

Percentage Water-Stable Particles, 0·5 mm. and Over.

Cultivation ...	... Range, 26·6–36·6 ;	Mean, 30·5
Grass ...	... Range, 45·8–57·8 ;	Mean, 52·9

An area of the grass land has now been ploughed and will be cropped regularly, soil samples being taken yearly to follow the effect on crumb structure. In addition, grass plots have been laid down on the old cultivated area in order to follow the building-up process.

ROTATION CROPS.

The season was not well suited to rotation crops, as the drought during January and February caused a considerable reduction in yield

of medium- and late-planted maize, as well as all leguminous crops. Early-planted maize was not seriously affected and very good yields were obtained.

Experimental work was confined to two maize variety trials, one medium-early and the other late-planted, in which the streak-resistant types bred here were compared with their parent varieties and with a type bred at Potchefstroom Experiment Station. Streak infestation during the season was the heaviest ever experienced on the Station and even early-planted maize, which normally escapes damage, suffered to some extent.

Counts of plants infected with streak to different degrees were made during the season and the figures for both trials, at the peaks of infection, are given as percentages in the table below.

Strain.	*Planted Nov. 16. Peak of Infection Feb. 12.*				*Planted Dec. 30. Peak of Infection Feb. 27.*			
	Light.	*Medium.*	*Heavy.*	*Total.*	*Light.*	*Medium.*	*Heavy.*	*Total.*
Hickory	7·9	8·7	6·9	23·5	10·3	46·8	40·1	97·3
Hickory, Streak-Resistant	1·7	1·7	0·9	4·3	31·5	24·3	6·9	62·7
Peruvian	2·1	0·8	0·8	3·7	18·0	12·7	3·2	33·9
Peruvian, Streak-Resistant	Nil	Nil	Nil	Nil	3·6	1·5	Nil	5·1
Peru × Hickory, Streak-Resistant	0·8	0·6	0·2	1·6	16·6	12·8	3·5	32·9
Potchefstroom Pearl ...	8·0	8·7	10·2	26·9	7·2	37·0	55·6	99·8

The final yield figures for both trials are shown in the following table.

Strain.	*Planted Nov. 16. lb. per acre grain.*	*Planted Dec. 30. lb. per acre grain.*
Hickory	2,835	1,435
Hickory, Streak-Resistant	2,151	1,477
Peruvian...	2,056	1,621
Peruvian, Streak-Resistant	1,350	967
Peru × Hickory, Streak-Resistant	2,319	1,742
Potchefstroom Pearl	2,246	671
Significant Difference, P = ·01	264	179

The resistant strains of Peruvian and Hickory show markedly greater resistance than their parents, the former being extremely good. As in the previous season, however, their yields are disappointing, even in the late planting where streak was very severe. Both strains give weaker plants than their parents and exhibit a greater tendency to lodge. The Hickory strain is of very doubtful use economically; the Peruvian could not possibly be of value as it stands, but, in view of its extremely high resistance, it might be of value as a parent in breeding for this character.

The P × H resistant strain is much more promising, although it did not come up to the Hickory parent in yield where streak was light. On this season's showing it would be the best type for planting where heavy streak infection is expected. Both this strain and the Hickory S.R. were multiplied and rogued for streak during the season, so should be improved for their resistance.

Damage by streak disease was severe in widespread areas, ranging from Natal to the northern Transvaal, and the requests for seed of resistant types far exceeded the supply.

The main leguminous crops grown were groundnuts, soya and tepary beans and pigeon pea. Both groundnuts and tepary beans gave only moderate yields, being badly affected by the January–February drought. The more drought-resisting soya bean gave a more satisfactory yield and good returns in view of the high price at present ruling.

SUMMARY.

1. The staff was increased to its pre-war level for cotton breeding and a full season's work was carried out, very satisfactory progress being made.

2. In a variety trial of U.4 strains, 5143, now in general cultivation, was again outyielded by two strains of other U.4 families.

3. The following hybrid material was carried a step further :—

(*a*) U.4 × Cambodia lots again gave excellent results. Bulks were carried forward for multiplication and inclusion in variety trials. Similarly promising material, though less advanced, was obtained from the U.4–M.U.8 crosses.

(*b*) U.4 and M.U.8 × Coker Wild's, F_2 and backcrosses. Some difficulty was experienced in finding good hairiness combined with the full Coker quality of lint, but many reasonably good plants were carried forward. A negative correlation was found between hairiness and lint length. Crosses of U.4 and M.U.8 with other " quality " *hirsutum* parents have been made or carried to F_2. Uganda B.P.52 appears to be a particularly promising parent.

(*c*) U.4 × Sea Island and Egyptian, F_3. This material showed extreme variation, including some plants with a leaf hairiness greater than anything else examined. Many plants were found with excellent lint and leaf hairiness and good field characters, thus providing most promising material for continued selection work.

4. A detailed microscopic examination was made of hairiness on various parts of the plant in a number of varieties and crosses, also on the leaf in the material under (*c*) above. The range in both density and length of hairs, is very much greater in the *barbadense* crosses than in the plain *hirsutum* material. Hairiness was found to vary appreciably with vegetative vigour, a lower vigour giving higher density, with more hairs per bunch, but the hairs are shorter.

5. An extremely close connection has been demonstrated between *hairiness* and *jassid-resistance* in a wide range of material. Both density and length of hairs are shown to be of importance. The evidence, taken as a whole, appears to indicate that hairiness *causes* resistance to jassid in the field. Hairiness of the stem is of very minor importance (if any) compared with that of the leaf.

6. Spinning test results on last year's samples show that the same set of strains produced appreciably better lint at Barberton than at Domira Bay.

7. Estimates of "crumb structure," carried out by Dr. W. S. Martin, showed that the red loam of the Station had deteriorated considerably in this respect after 15 years of continued cultivation.

8. Streak-resistant strains of Hickory and Peruvian maize again gave better resistance, but lower yields, than their parents. A resistant strain of the inter-varietal cross proved more promising.

PROGRAMME OF WORK FOR 1943-44.

Cotton Breeding.

Variety Trial.—A large number of strains from the U.4–Cambodia cross will be tested against the best U.4 strains in a balanced incomplete-block variety trial. It is hoped to send lint samples of these strains for spinning tests.

Hybridization.—Work will be continued on the material described in the present Report. Over 600 single-plant selections and a large number of bulks have been carried forward.

Hairiness.—Microscopic work will be continued and use will be made of a photographic method of obtaining records, for which a satisfactory technique has been evolved. A further study will be made of variation on the plant and through the season.

Jassid-Resistance.—The relation between jassid-resistance and hairiness will be further investigated. A trial has been laid down in which a number of standard *hirsutum* strains, varying widely in hairiness, are alternated with a very susceptible type to give a uniformly heavy jassid population. Heavily manured and unmanured blocks are replicated. Jassid counts and examinations of hairiness will be carried out on the strains.

A somewhat similar trial with a mixture of the *barbadense* crosses is also laid down. Here single plants covering the widest possible range of hairiness will be used for records.

Experiments.

Minor Elements.—An experiment will be carried out on the red loam to test the effect of various minor elements on the development of cotton and on its susceptibility to *Alternaria*. The elements included are copper, zinc, magnesium, manganese and boron, separately and together, with and without potassium.

Soil Structure.—A four-acre plot of red loam, newly opened from grass, will be cropped with cotton and maize alternating, two acres under each crop yearly. The effect on " crumb structure " will be followed from soil samples taken periodically from this area and from the grass camp alongside.

An experiment has been started to test the effect, on the red loam cultivated area, of resting crops of Napier and Rhodes grasses. Both two-year and three-year rests are included, and their effect on the " crumb structure " and on the crops following, cotton and maize, will be noted.

ROTATION CROPS.

Variety trials with streak-resistant maize will be continued, but the Peruvian resistant strain will be omitted.

SWAZILAND

COTTON EXPERIMENT STATIONS, BREMERSDORP AND CROYDON.

PROGRESS REPORT FOR THE SEASON 1942-43

BY

J. V. LOCHRIE.

Introduction.

The proposed programme of experimental work was carried out and, though the season was a very unfavourable one, the progress made was fairly satisfactory. Mr. Hutchinson was again engaged in promoting and supervising native cotton-growing and in assisting the Government Food Production Scheme.

The main work of the Stations continued on problems of soil fertility, while selection work and strain tests were carried out on cotton, cereals and other food crops.

In general the season was one of high, but very badly distributed, rainfall and yields of all crops were poor. The season started well with winter rains for ploughing and excellent conditions in spring for planting and plant establishment. As usual little advantage was taken of these circumstances by the cultivator and, as the very early crops were the only ones to evade the drought period, this was reflected in a serious food shortage in the country.

Conditions of good rains and low temperatures continued until mid-January and this was followed by a long dry spell lasting into March. The main maize crops were in the critical flowering stage at this period and yields were seriously affected. The effect was particularly severe in areas of native cultivation, denuded of fertility and inefficiently cultivated.

The cotton acreage was small and yields were poor due to a combination of factors :—(*a*) low temperatures throughout the season ; (*b*) drought conditions in February which restricted flowering and caused shedding ; (*c*) the crop recovery following the March and April rains came to nothing owing to the onset of cold weather and the increase in stainer ; (*d*) bollworm infestation was general and fairly severe.

BREMERSDORP STATION.

Meteorology.

The rainfall was high—40 inches from September to June—but the distribution was not favourable. Ample rains fell in winter to enable ploughing to be done and, with the advent of early spring rains, planting was started considerably earlier than is usual here. Some of the maize crop and most of the cotton were planted in late September and sufficient rain fell during October to establish the crops. The conditions

during November and December were of high rainfall and excessive cloudiness favourable to the maize crops. In the low temperatures and lack of sun, cotton, particularly on the heavier soils, made very disappointing growth and development. Rainfall in January and February was low and the cotton benefited by the drier and warmer conditions, but unfortunately red bollworm increased considerably and much of the early formed crop was lost. The heavy rains of March and April were accompanied by a heavy increase of stainer, and this, together with the rapid fall in temperature, completely cut off the later formed crop.

Early-planted maize got away well and excellent yields were reaped. The later plantings were affected by the shortage of rain at flowering and this is reflected in the yields, which ranged from 14 bags per acre from the earliest crop to 4 bags from that planted in December.

Agriculture.

Fertilizer and Rotation Experiment.—This experiment, which is now in its fifth year, was planted to maize. The rotation is maize and cotton alternating, except for the Nil (B) series which is planted to maize each year.

The treatments are applied in alternate years, *i.e.*, to maize only, except for KMP (B) which is applied annually.

Treatment.	*Rate per acre.*	*Yield per acre lb. grain.*	*Green Weight (25 days).*
Nil (A)		1,910	450
Nil (B)		1,460	446
P	200 lb. Supers.	2,660	551
KM	4 tons Compost	2,500	519
KMP (A)	KM plus P	2,750	581
KMP (B)	KM plus P	3,230	635
Significant difference required P.=·05		256	53
" " " P.=·01		351	72

Hickory King maize was planted on September 28th using two seeds per hole. Germination was very good and growth was excellent in the high moisture conditions. Infestation by Top Grub was severe but, despite some losses from this cause, the yields were good.

Stand.—The stand was uniformly good with no differences between treatments.

Growth.—Treatment differences were early apparent and became more pronounced as the season advanced. The crop was thinned at 23 days from planting and the thinnings weighed. At this stage Nil (A) and Nil (B) were equal and both significantly less than all other treatments. The differences follow the same trend as in all the previous seasons, but are less striking, owing to the much earlier sampling date. Observations later in the season showed very obvious differences with Nil (A) strikingly better than the continuous maize plot, Nil (B). Unfortunately the lodging in the crop, due to the infestation of Top Grub, and the wet spell at harvest made it impracticable to take straw weights.

Yield.—The yields of grain follow the same trend as the growth observations. The effect of the annual application is outstanding and indicates a substantial residual effect. As in the previous years of the experiment, KM and P show high and equal increases over the unfertilised series.

A noteworthy feature of the experiment is the rotational value of cotton. In the 1940–41 experiment the effect of cotton was reflected in the growth of the maize, but not in yield, owing it is considered, to the then still fairly high witchweed infestation. The whole area is now free of the parasite and the effect of cotton is indicated by a high yield increase. A similar effect of cotton is reported in an experiment to be described later.

Fertilizer Experiment (*B*).—This experiment, which was in maize in the preceding seasons, was planted to cotton. The layout is on the loam and is designed to test the effects of nitrogen, phosphate and potash alone and in combination, the interactions being partially confounded. The treatments were applied for the third successive year.

As with other cotton on the Station the crop here was extremely poor, averaging under 300 lb. seed-cotton per acre. The crop was planted very early—on September 26th—and germination and stands were good. The lack of sun and the semi-waterlogged conditions during November and December retarded growth and development. Conditions improved with the dry weather in January and February, but considerable losses were experienced from bollworm. Following the long spell of wet weather in April there was a rapid drop in temperatures and such crop as was reaped came from flowers produced up to mid-February. Growth and development records were taken and a summary of the results is given below.

Growth.—Samples were taken at thinning and these showed highly significant increases from phosphate (P.) and potash (K.). This effect of P. is in line with previous experiments both with cotton and maize.

A second sample was taken before the plants were uprooted and here again P. and K. gave highly significant increases, with N. somewhat less.

Yield.—Significant yield increases were obtained both from P. and to a lesser degree from K.

Flowering.—Flowering records were taken and these show a highly significant increase following both phosphate and potash. The PN interaction also showed a significant increase.

As in the two previous years of the experiment under maize, the outstanding effect was that of phosphate. The effect of potash on this soil is interesting. In the first two seasons of the experiment, under maize, applications of potash had no effect. Under cotton in the present season this treatment gave significant increases in yield,

flower production and plant weight. In a previous experiment at Bremersdorp—summarized in Reports from Experiment Stations, 1936–37—applications of potash showed yield increases with cotton but had a depressing effect on the yield of maize.

This experiment will be planted to maize next season to observe residual effects.

Fertilizer Experiment (*C*).—This experiment, now in its second year, was planted to cotton. It is laid out on the light granite soil which is low in organic matter and poorer than the loam in all main plant nutrients. The layout is of factorial design, with three levels of N, P, and K singly, and in all combinations. The treatments and rates of application were the same as last season.

N1 = 150 lb. per acre nitrate of soda (top-dressed)
N2 = 300 „ „ „ „
P1 = 200 „ „ superphosphate (16%).
P2 = 400 „ „ „
K1 = 150 „ muriate of potash.
K2 = 300 „ „ „

Cotton was planted on September 25th and stands were excellent. Early growth was not particularly good, though better than on the loam. Red bollworm was early in evidence and, though not epidemic, the steady loss was serious. The dry spell in February caused slight shedding and a cessation of flowering and, though heavy rains fell later, the crop did not recover owing to the early onset of cold weather and the increase in stainer. The low average yield of 300 lb. per acre was produced from the flowering prior to mid-February.

Growth.—Samples were taken at thinning, too early for the effect of the N. top-dressing to be seen. The results show a highly significant increase from P. but no difference between P2 and P1.

Yield.—Highly significant yield increase from K., but no difference between K1 and K2.

Flowering.—Daily flowering counts were made up to the cessation of flowering in February. The totals during that period show high significant increase from K. and P. As with growth and yield there was no advantage of the double application over the single.

Considering the low yield and the abnormal seasonal conditions, the results obtained in this and the experiment described earlier must not be overvalued. However there are certain points of interest and corroboration of previous work :—(*a*) the beneficial effect of potash on cotton yield compared with no effect or even a depressing effect on maize ; (*b*) the importance of phosphate on both soil types on the Station.

The experiment will be continued in the following season to obtain information on residual effects.

Soil Restoration Experiment.—This experiment was laid out two seasons ago to test the effects of bush fallow and other crops in restoring fertility. The site of the experiment had been badly worked for a

considerable period and, before the land was taken over for experimental work was subject to erosion and denuded of fertility. The treatments, given in detail in last season's report, include continuous maize and a rotation of annual crops, in addition to resting crops of grass and pigeon pea.

The following notes indicate the poor productivity of the site and the progress of the various regenerative crops.

The experiment received no fertilizer and the maize yield was again low—under 300 lb. grain per acre against 1,400 lb. from unfertilized maize on the rest of the Station. Maize followed cotton in the rotation series in this experiment and the yields here were very significantly higher, being almost double those obtained from the continuous maize. This beneficial effect of cotton corroborates the findings in the Fertilizer and Rotation Experiment described earlier.

Bush Fallow.—The predominance of annual weeds was again the feature. Analyses of the vegetative cover were made. These showed over 95% annual weeds in the first season of fallow, the balance being made up of grasses of little value. In the second year of fallow the proportion of grasses has increased to about 20% with some of the better grass species appearing.

Rhodes Grass.—In view of the poverty of this soil the performance of this grass is gratifying. In the first season the growth is fair, but by the second season it has provided an excellent cover. This grass shows distinct promise for soil regeneration on the sorely abused loam soils of the country.

In the series interplanted with pigeon pea growth is less good owing to shading, but should improve where the pigeon pea is kept down either by grazing or cutting.

Pigeon Pea.—Growth of this crop is very good. Up to the present it has been allowed to grow to maturity to provide seed, but in future it is intended to cut it down at intervals to afford a closer approximation to conditions where grazing would be carried on.

It was mentioned in the report of last season that the above crops had been used, not necessarily as the best for the purpose, but because they were known to grow in the area and to fulfil such conditions as being reasonably easy to establish and to plough out when cropping is resumed. A start has been made towards a collection of grasses and legumes which have shown promise elsewhere ; this is part of a broader scheme of using the Station as an introduction centre where promising grasses and other forage crops, including legumes, may be bulked for issue and trial in the different climatic conditions and soil types of the country.

I am indebted to the officers of the Soil and Veld Conservation Section of the Union Department of Agriculture both for advice and the provision of planting material for trial.

Cotton Strain Trial.

A trial of a number of strains from the Barberton Station was planted towards the end of October under good moisture conditions. As with the other cotton on the Station growth in the early stages was slow ; red bollworm was soon evident and accounted for much of the early-formed crop. Plant growth improved greatly in the dry spell of January and February, and flowering was satisfactory. The fate of this main flowering was similar to that of the other cotton on the Station. Cold weather accompanied and followed the heavy rains of March and April. In addition, stainer bred up rapidly and such crop as might have opened was ruined by bacterial and stainer-carried bollrot. The little crop which was reaped—230 lb. seed-cotton per acre—came from bolls which had escaped bollworm in the early part of the season.

Considerable yield differences occurred between strains but, under the circumstances in which the crop was produced, little value can be placed on them.

Rotation Crops.

Maize Breeding.—For reasons given last year, selection work on the white flint maize types has been discontinued. Bulks of the four main strains were grown and mass selected.

Hickory King is the most generally grown of the late-maturing white dent types and a large number of selections were made in commercial crops last season. Some hundred of these were grown this season and exhibited a wide range of differences in plant characters. As a result of the year's observations 25 have been retained for further selection and trial.

Maize Strain Trial.—The four flint strains were planted early in December and made good early growth. Tasselling and silking coincided with the very dry period from late January onward. Many of the tassels dried off and fertilization was affected. Yields were low compared with the early-planted maize, but no differences between strains appeared. This yield similarity confirms previous results at both Stations and the strains will now be issued to growers.

Maize Spacing.—Previous experiments at Bremersdorp have indicated the optimum spacing under good farming conditions to be about 15 inches apart in 3 feet rows. In view of the increasing scarcity of labour for hoeing, the present experiment was designed to test the effect of similar plant densities per acre, but arranged in different row widths, etc. The wider rows permit of increased use of mechanical cultivation both for the control of weeds and of the witchweed parasite. The arrangements were :—3′×15″ (1 plant) ; 3′×2′ 6″ (2 plants) ; 6′×1′ 3″ (2 plants) ; 6′×2′ 6″ (4 plants).

The experiment was planted late and was seriously affected by drought at flowering. The last mentioned spacing was significantly lower yielding than all others. Under this season's conditions the

grouping of 4 plants per hole was not satisfactory as a high percentage of the plants were barren.

Streak Disease.—Hitherto the occurrence of Streak in maize has been slight and confined to late-planted crops. This season the disease showed a disquieting increase. Strains with a high resistance have been obtained from the Barberton Station and these will be bulked for late plantings and for winter-grown crops where these are grown.

Kaffircorn.—Work on this crop was confined to mass selection in bulks of the two main strains which are now in general cultivation. As with cotton, the season was unfavourable for kaffircorn and yields were much lower than is usual on this Station.

Of the two main strains, P 127 is a stout-stemmed type with a plant height of only 3 feet, while the other—74 T—is approximately 4 feet 6 inches high. Spacing experiments at both Stations last season indicated that both these strains would benefit from a closer spacing than is customary in general cultivation. A row-width experiment was conducted with both strains using rows of 36 inches, 30 inches and 24 inches, with a standard spacing in the row. With both strains the yield per acre increased with each reduction in row-width and fully confirm the indications of the previous season.

Soya Beans.—Trials of strains of soyas were continued and the results corroborated those of last season. One of the introductions again outyielded the standard strain, Y 1, and this is being retained for bulk cultivation. The others are very early maturing and again yielded poorly and have now been discarded.

Miscellaneous Crops.—As in previous years a number of crops were grown as bulks. These include crops on which experimentation has been concluded, new introductions for observation, and crops to maintain and provide supplies of planting material.

Sunflowers.—Two varieties which have done well here were carried on and mass selected to maintain seed supplies.

Sunnhemp.—This crop is widely grown as a green manure crop. Attention is now focussed on sunnhemp as a source of fibre in South Africa and experiments along these lines are planned for next season.

Groundnuts.—This is the main grain legume of the country and it occupies a considerable part of the legume rotation on the Station. Germination and growth were good, but some losses were experienced during the wet weather at harvest. In spite of this the satisfactory yield of 1,200 lb. of unshelled nuts per acre was reaped.

Sweet Potatoes.—A range of improved varieties was grown for food and for the provision of planting material. Some of these show great improvement over the locally grown types and the demand for planting material is considerable.

Cassava.—This crop is grown on the Station as a source of food and to supply planting material. The labour staff readily eat the

roots and the leaves, and it is hoped that more active efforts will be made to extend its cultivation amongst natives. Food shortage among the Swazi people is the rule and with the present methods of farming a steady loss of fertility and productivity will continue.

Pigeon Pea.—This is proving itself as a regenerative cover on worn-out lands. Like cassava it has possibilities as a semi-permanent crop in native areas.

Okra.—With the view of obtaining easily-grown vegetables for addition to the native dietary, some varieties of okra were obtained from the Amani Institute. These cropped well and appealed to the palate of the Swazi. Seed is bulked for trial in other areas.

Grasses.—A collection of grasses is being made with the assistance of the Soil and Veld Section of the Union Department of Agriculture. These include types suitable both for pasture and hay.

CROYDON STATION.

This Sub-Station is more representative of the cotton-growing area than is Bremersdorp. In general it is hotter and drier and is about 1,000 feet lower than the Bremersdorp Station. The site is on light, sandy loam typical of a large part of the potential cotton-growing area.

Meteorology.

The rainfall from September to June was high for this area—30 inches—but the distribution was most unfavourable. Sufficient rain fell in winter and early spring to permit of ploughing being done, and the cotton and maize crops were planted in October and early November. Conditions for planting were good and crops established well. Though colder than usual, the temperatures were higher than at Bremersdorp and the growth of cotton plants was satisfactory. The difference between the growth at the two Stations was very noticeable. December and part of January were dry and sunny and cotton benefited. Maize was at a critical stage and was saved by a good fall of rain on January 15th. Considerable losses of early crop occurred through red bollworm, but despite this the prospects at this stage were good. During the 7 weeks following only 1 inch of rain fell and this period was disastrous to cotton as all flowering ceased and heavy shedding occurred. Rainfall in March and April was heavy and a good crop of bolls was set. Temperatures fell rapidly and this, combined with a heavy stainer infestation, accounted for the late crop.

All crops reaped came from the early-produced bolls and yields were low, averaging 600 lb. seed-cotton per acre from the October plantings and 300 lb. from cotton planted a month later. These figures confirm the view of the importance of early planting in these areas, where many factors contribute to a shortening of the season .

AGRICULTURE.

Fertilizer experiments were continued both with maize and cotton. As at Bremersdorp all combinations of N, P, and K, were included in the layout, in which all interactions were partially confounded.

Fertilizer Experiment (A) Maize.—This is the third season of the experiment and earlier results were described in the preceding reports.

The fertilizer treatments were applied for the third successive year and maize was planted on November 9th under good conditions, but moisture shortage occurred in January and the crop was saved by a timely fall in mid-January. Differences in growth were early apparent and continued throughout the season, with the nitrogen treatment outstanding. Yields were satisfactory considering the season and varied from 1,200 lb. grain per acre from the unfertilized series to 1,800 lb. on the N plots.

Growth.—Samples were taken 30 days after planting, this being 25 days after top-dressing with nitrate of soda. The N effect was outstanding and highly significant. In addition, there was a positive interaction of PK. The results are, in general, similar to those obtained in the same experiment under maize two seasons ago.

Yield.—The outstanding treatment was nitrogen which gave a highly significant yield increase of grain.

Stalks.—Stalks were weighed after harvest and highly significant increases were obtained from N and from P.

Tasselling.—Counts were made at 66 days and show a significant increase from N.

The substantial increases in plant growth and yield following applications of nitrogen, and to a lesser degree phosphate, confirm the findings in this and other experiments at Croydon.

The position of potash in the three years of this experiment is somewhat obscure and contradictory. In the first season under maize the effect of potash in increased growth and yields was considerable, while in the present season no effects were found. No explanation can be offered at this stage, but it may be that the time of application of the muriate of potash and the differences in the rainfall of the seasons on this light sandy soil may have contributed. In the first season—of good effects of potash—application was made just before planting and the rainfall was light. In the subsequent years, applications were made in August and were followed by fairly heavy spring rainstorms.

Fertilizer Experiment (B) Cotton.—This experiment, which is similar to experiment (A), is now in its second year, having been planted to maize last season.

The land was ploughed in winter and later re-ploughed to cover the superphosphate and potash which were applied on August 14th. Nitrate of soda was applied as a top-dressing after the cotton had come through.

The cotton crop was planted in mid-September and stands and early growth were good. By the end of January the plants were carrying a heavy crop of bolls and, though bollworm was general and fairly severe, the prospects were good. With the continued shortage of moisture during February the outlook changed ; flowering ceased and considerable shedding of young bolls occurred. Following the heavy rains of late March and April there was an excellent boll setting, but no further crop opened, owing to cold weather and heavy infestation of stainer and bollworm. The crop of 600 lb. seed-cotton per acre was made from flowers produced up to early February.

Growth.—Samples taken at thinning showed a highly significant increase from P. At this early stage the effect of N was not fully apparent. A further sample was taken 62 days later and this showed highly significant growth increase from N and to a lesser extent from P.

Yield.—Yields were low and the only treatment effect was an indication of increase from N.

Flowering.—Flowers produced up to mid-February, *i.e.*, the effective flowering period this season, show a high increase from N and a significant but lesser increase from P.

These results are similar in trend to those obtained in Experiment (A) with maize. The outstanding effect in both cases is that of N, with a smaller effect of P. In both, the effect of K was negligible.

Cotton Strain Trials.

The trial described in the Bremersdorp section of the Report was duplicated at Croydon and unfortunately suffered the same fate.

Planting was done in early November and stands and early growth were satisfactory. Being a month later planted than the cotton in the fertilizer experiment, it stood up better to the February drought. No shedding occurred, but flowering tapered off and ceased by the end of February. As with the other cotton on the Station, heavy flowering followed the April rains, but stainer-carried bollrot and bollworm accounted for the late crop. The very low yield of 300 lb. of seed-cotton per acre was just half that reaped from the crop planted a month earlier.

Considerable yield differences occurred between strains but as at Bremersdorp little reliance can be placed on them owing to the low yields and the character of the season.

Rotation Crops.

Maize.—This Station is typical of the area for which the flint maize strains were selected.

A trial of the four main strains was planted early in October and, like the maize in the Fertilizer Experiment, it was out of danger when the drought of February occurred. Stands were good and conditions for the crop were fairly satisfactory, though the cobs would have filled out better with more moisture about the end of January. The yield differences between strains were inconsiderable and the average of 1,600 lb. grain per acre is very satisfactory.

Kaffircorn.—The combined strain and row-width experiment described in the Bremersdorp section was duplicated here. The crop was planted on December 2nd, and from then until harvest only 6 inches of rain fell. Heading took place during the almost rainless February and the yield of 900 lb. of grain per acre is eloquent testimony to the suitability of these short, early-maturing strains to dry conditions. There was no significant difference in yield between any of the treatments, the very close row-width of 2 feet holding its own with the hitherto standard of 3 feet. Under good rainfall conditions last season the higher plant density showed to advantage and it would appear that such a practice may be recommended with safety.

Groundnuts.—A further experiment was planted to compare the effect of planting on the flat compared with a later ridging up of the plants. As with some half dozen experiments in the past at both Stations and under various conditions of rainfall, no yield differences appeared. It is probable that the claims made here in favour of ridging are the result of the weed destruction caused by the ridging operation rather than the effect of the ridge.

Miscellaneous Crops.

As at Bremersdorp, a number of crops are grown as bulks for food and to provide supplies of planting material. The range is substantially the same at both Stations.

Summary.

(1) The season was most erratic and unfavourable, marked by high, but poorly distributed, rainfall, and by temperatures lower than normal. Pests and diseases were also considerable factors :— red bollworm and stainer on cotton, and Top Grub on cereal crops.

(2) Cotton strain tests were carried out in conjunction with the Barberton Station.

(3) A series of Fertilizer Experiments was conducted both on maize and on cotton crops. The experiments are described and the main results are given. These confirm previous work on the importance of phosphate at Bremersdorp and nitrogen at Croydon. In the Rotation Experiment the effect of cotton on the growth and yield of a succeeding maize crop was pronounced.

(4) Selection work on maize and strain tests of maize and kaffircorn were carried out.

(5) Combined strain and row-width trials of the early-maturing kaffircorn types were conducted.

(6) The progress of the various crops on the Soil Restoration Experiment is described.

(7) A range of crops was grown to provide food and planting material for issue to growers. In addition to crops already proved to be suitable to the country, some further introductions were made.

PROGRAMME FOR THE SEASON 1943-1944.

At the end of the 1942–43 season the Government Farm on which the Bremersdorp Station is situated was placed under the control of the writer.

It is proposed to develop the farm as a general agricultural experiment station and to extend the basis of the work at present being conducted by the Corporation. In addition, some further land has been made available at Croydon as the present area was restricted.

(1) Cotton strain trials will be continued.

(2) The present fertilizer experiments will be continued as follows :

(*a*) The combined fertilizer and rotation experiment will be planted to cotton. In this, its sixth year, it will afford information on direct and residual effects.

(*b*) The factorial fertilizer experiments (B) and (C) at Bremersdorp will be planted to maize. No further direct applications will be made and the experiments will provide information on the residual fertilizer effects.

(*c*) The similar experiments at Croydon will be planted—one to maize and one to cotton—to test residual effects.

(*d*) A combined rotation and fertilizer experiment is proposed for Croydon. The layout is designed to provide information as follows :—(1) Effect of green manuring compared with the application of compost. (2) Annual applications of small amounts of compost and phosphate compared with larger amounts at longer intervals. (3) Rotation effects of various crops.

(*e*) In view of the present scarcity of superphosphate, an experiment will be conducted at both Stations to test the low grade South African rock phosphate as a substitute, in whole or in part, for superphosphate.

(3) The soil restoration experiment will continue in its third year.

(4) Selection work on white flint maize and on kaffircorn has been discontinued. Breeding work on Hickory King maize will be continued.

(5) Various experiments with sunnhemp are proposed. Earlier in this report mention was made of the attention being paid to sunnhemp as a fibre crop in South Africa. A relatively cheap

decorticating machine has been perfected by an officer of the Southern Rhodesian Government and this overcomes the difficulty of fibre extraction. Sunnhemp grows well in most areas and its value in conserving soil fertility is such that any development which might lead to its extension in cultivation is important. So far the crop has only been grown as a green manure and the conditions necessary for the production of good quality fibre have not been studied. The following experiments are proposed :—(*a*) Plant density and manurial experiments at both Stations. (*b*) Sunnhemp utilization experiment. This is planned to determine the relative value of sunnhemp ploughed under in the usual way ; the stalks reaped for fibre and the stubble and residues after rotting ploughed in ; the stubble only ploughed under.

(6) Green manure and witchweed control. In view of the severity of witchweed infestation in many areas, trap cropping with Sudan grass and kaffircorn is becoming increasingly important. The present experiment is designed to compare the relative effects of such crops on witchweed control and also their value as green manures compared with sunnhemp.

(7) Work on the introduction and trial of grasses and legumes suitable for hay and pasture and for soil regeneration will be extended.

(8) Some work on water and soil conservation by trials of various contouring systems both on cultivated land and on grass is proposed.

NOTE ON NATIVE COTTON PRODUCTION

BY

H. HUTCHINSON.

Cotton's only appeal to the native grower lies in its cash value in relation to the price and availability of food crops and to the existence of other sources of money. The Swazi has a definite need for a certain amount of cash, and cotton, at the outbreak of war, was gaining ground as a means of supplying it. In recent years, however, money has miraculously appeared in large sums, as allowances to dependents of soldiers in the African Auxiliary Pioneer Corps, from enhanced prices for cream at native separating stations, and from quite astonishing prices for cattle. (The average family may have two head to sell per annum and where previously the price was £4 to £5 per head it is now £10 to £12.) This wealth has encouraged the Swazi to indulge his desire for leisure to such an extent that even food production has been neglected on the comfortable supposition that money would buy all requirements from the Union. This has proved not to be the case and such work as cannot be avoided is now directed to the production of food crops, though on the erroneous assumption that extensive, but careless ploughing and planting will take the place of thorough cultivation. The value of cotton for rotation with grain and for land heavily infested with witchweed is practically ignored by the average

cultivator. He has often said that there is too much work in cotton and now with money burning a hole in his pocket and the local price of lint no more than it was three or four years ago, he feels sure of it. It is not surprising, therefore, that cotton production has declined and is likely to continue to do so.

At the beginning of the season all experienced growers were preparing to plant the crop, but on a smaller scale than in previous years, and there were very few new recruits. Unfortunately the season proved to be unfavourable ; cool weather made growth slow and a severe drought of six weeks' duration in January and February caused considerable loss of crop, though the damage was noticeably less than to native maize and kaffircorn which, indeed, were practically wiped out throughout the Territory. March rains were sufficient to keep the cotton going and in April fair crops were opening, but frequent heavy rains during the month so damaged and dirtied the seed-cotton or compressed it into the boll so much that owners were too discouraged to pick it. Subsequent abnormally cold weather prevented further fruiting. Insect pest attack was not heavy ; *D. fasciatus* was more in evidence than usual, but there was little staining.

The total production was 8,400 lb. of seed-cotton, all quite carefully picked clean of leaf trash. The ginning outturn was 32·8%.

The difficulty of marketing the lint locally still remains. In the two previous years it has been bought by African Explosives at $8\frac{1}{4}$d. per lb. but this year owing to heavy purchases from the East African Territories the local crop was not required and at the time of writing it is still unsold. There is a considerable manufacture of cotton-and-wool blankets in the Union, but this trade apparently needs a cotton of about $\frac{7}{8}$ inch staple which can be bought cheaply from the Belgian Congo and no price really encouraging to the local grower can be obtained.

The writer has been otherwise engaged in promoting food production and it is perhaps worth mentioning that during three successive difficult seasons satisfactory and profitable crops of maize have been obtained in an area bordering on the bushveld where for many years agriculture was regarded as too precarious to be practicable.

Summary.

The boom in native cattle sales is such that cotton finds no favour as a cash crop and agriculture is being so neglected that all efforts are directed towards producing urgently needed foodstuffs.

Total native production of seed-cotton was only 8,400 lb. compared with 11,200 lb. last year and 21,900 lb. in 1941.

Marketing of the lint is difficult and local prices are not encouraging in face of the high prices for all other commodities.

SOUTHERN RHODESIA

BY
G. S. CAMERON.

Introductory Note.

It is safe to assume nowadays that cotton-growing in Southern Rhodesia has taken a permanent place in the agricultural economics of the country. This is not to say that the crop has got a firm footing throughout the length and breadth of the Colony, but there no longer seems to exist the doubts and fears, once so prevalent, as to whether soil and climatic conditions are suited to cotton-growing or not.

For many years those connected with the industry have maintained a conservative attitude and carefully avoided any action that could be interpreted as " boosting " the crop. It is hoped that this attitude will be continued in the future as in the past. At the same time, it is being realised gradually that cotton is possibly about the safest crop that can be grown, provided farmers can be assured of fair and reasonable prices. As soon as these were stabilised at a guaranteed price, the cotton crop immediately went ahead and it is unlikely that there will be any lessening of production from now onwards.

On the contrary, it is anticipated that there will be a steady increase year by year as more and more farmers come to realise the reliability of the crop. This, of course, assumes that a fairly even relationship will be maintained between the prices of cotton and other primary products.

It was thought for a time that a bonus promised to maize growers for the coming season, under certain qualifying conditions, might reduce the area to be planted to cotton, but this is offset by a shortage of maize fertiliser. As cotton does not benefit from artificial fertilisers, applied as a top dressing, there is a natural inclination to plant cotton where maize, without artificial fertiliser, would not give an economic return.

In a young Colony like Southern Rhodesia, there has to be a nice adjustment between prices for the different primary products, otherwise one goes ahead at the expense of others, and the whole system of agriculture is thrown out of gear. Thus, if cotton prices are fixed at too high a level, there will be a shortage of maize. On the other hand, if maize is overproduced, the surplus has to be exported at a loss. In addition to being a useful rotation crop, it is obvious that cotton as a cash crop takes a definite key place in the rural economy of the country. As far as Southern Rhodesia is concerned, it is the only crop that can be grown, processed and finally sold within the Colony without fear of over-production for many years to come.

COTTON BREEDING STATION, GATOOMA.

PROGRESS REPORT FOR THE SEASON 1942-43.

Lack of plant breeding staff, coupled with unforeseen developments in other directions, has reduced the effectiveness of the Station's output over the last two seasons, but more so in the season under review. Even with a programme of work greatly reduced in its scope, there has not been time to attend to matters badly requiring attention, and a fair amount of effort has been expended without getting equivalent results.

For instance, it was not possible to undertake single-plant selection work at all. The most that could be done was to eliminate from an accumulation of progeny rows and crossed material from previous years the strains that showed susceptibility to jassid as well as other defects.

Meteorology.

Following two very dry years in succession, the season developed into one of the wettest, and in some areas flood conditions prevailed. In Matabeleland, the western part of the Colony, rains were late in arriving, while in Mashonaland, the eastern part, rains were early and continuous.

On the Cotton Station, the rains arrived too late to give promise of a good cotton crop and they continued, as elsewhere, very late into the Autumn.

In contrast to the previous year, the cotton crop opened late.

The total rainfall for the season amounted to 36·17 inches compared with 21·79 inches and 33·2 inches in the two preceding seasons.

Agriculture.

It was anticipated as the season developed that the majority of the cotton crops would fail through excessive moisture, both in the soil and in the atmosphere. On the whole, however, they pulled through remarkably well, and the total crop is not likely to be very far behind that of the previous season. In the Hartley district, where rains were early and not quite so heavy as in some other districts, yields were remarkably good.

As may be expected in such seasons, there was much bad opening, excessive staining and poor seed.

Maize crops were good, although, in general, they have not come up to expectation. On the Cotton Station the average yield per acre amounted to 10·3 bags of 200 lb. as compared with 7·2 bags the previous year.

Soya beans are a comparatively new crop to Southern Rhodesia, and, after preliminary small-scale trials, were planted on a more extensive scale. 6·5 acres yielded an average of 700 lb. per acre.

So far, this crop does not appear to suffer from pests or diseases, and there is reason to expect a rapid increase in its production.

A fairly large acreage was planted to sunnhemp (*a*) for green crop to be ploughed under and (*b*) for seed. The season proved favourable to the former, but the seed crop did not turn out very well.

Four acres planted to potatoes gave a very poor return. A prolonged drought following planting reduced the stand, and seed was barely recovered.

Livestock.

Although there was ample food available to fatten off a larger number of steers than the previous year, it was not possible to do so because of difficulty in procuring stock. Thirty head of grade Aberdeen Angus are in process of being fattened for the Cold Storage Commission. These appear to be doing remarkably well, but final results will not be available in time for inclusion in this Progress Report.

Breeding and Genetics.

As mentioned in last year's Progress Report, a new strain, 9L18, was issued to a limited number of farmers for multiplication purposes. This strain has behaved well in a difficult season, although it is not likely to give a very good seed return. This is partly due to the season, and partly to the style and habit of the plant itself. It is inclined to grow tall, and the leaves are large and offer considerable shade to stainers and other insects. The whole of the seed from this year's crop of 9L18 is being acid-delinted, and the heavy water sinkers retained for distribution. Although it is not what one might consider a good " wet season " cotton, the farmers who grew it were favourably impressed with its performance, and there is a brisk demand for 9L18 seed.

The strain which is due to follow 9L18 in commercial cultivation, 9L34, is in process of being bulked up on the Cotton Station. It was hoped that a certain amount of this strain would be ready to go out for first multiplication by selected farmers this year, but it has been decided to keep it back for at least one year more. In practice, it is not advisable to have more than two strains in general cultivation throughout the country at one and the same time. Also, it will be better for another year's " cleansing," or roguing on the Cotton Station.

The multiplication was not good owing to poor stands of plants, resulting from the use of too low a seed rate. Ordinarily, only acid-delinted seed would have been used, but in the interests of economy by saving sulphuric acid, the usual practice was discontinued. The results proved the futility of attempting to over-economise, and the lesson learned, it is hoped, has been taken to heart. In spite of adverse conditions, however, this strain finished up remarkably well. Considering that it was late-planted in a year of late autumn rains and much damage from jassid, 9L34 gives promise of being hardy, prolific and producing lint of good length and character.

Single-Plant Selections.—As already mentioned, it was not possible to devote sufficient time to taking single-plant selections. There was a large accumulation of progeny rows and small bulks of Station crosses. Most of these have been discarded. Only 64 have been retained for further observation out of a total of five hundred. It was a good season for carrying out eliminating processes, and the survivors are all the more likely to prove useful in future.

Derivatives from progenies of the 1940 colchicine-treated selections continued to give evidence of prolific flowering. Unfortunately they went down badly to jassid.

Yield Trials.—The three best strains from the previous year's trials, together with three others, were incorporated in two sets of yield trials laid out, one on fairly poor land and the other on land of medium fertility. In both cases the stands were so erratic as to render the trials valueless. In an attempt to make the best of a bad job, comparisons were made between yields per 100 plants, although it is realised that such a practice favours plants from plots where stands are bad. The attempt, for what it is worth, gave significant differences between the leading strains, and in the same order as the previous year, namely, 9L34, 6C6, and 9L18.

Station Crosses.—The 7Cs again showed a tendency to grow tall, rank, and inclined to leafiness. Among those retained, their outstanding characteristic is their resistance to jassid, which is most marked.

Entomology.

Locusts.—No locust damage was experienced on the Cotton Station, and no complaints were received from the Districts. This is the third consecutive season that it has been possible to report no locust damage.

Jassids.—Numerically, jassids were no more in evidence than in former years, but their effect was much more noticeable. Strains which were considered " safe " in former years went down badly, and weaknesses showed up in some which were thought to be highly resistant.

Bollworms.—A noticeable feature of the year was the almost negligible incidence of American bollworms contrasted with a large increase in the number of Sudan bollworms. The latter were prevalent throughout the season, and as the Station cotton was planted late, it suffered considerable damage.

Stainers.—Stainers were plentiful and did much damage. *D. intermedius* took the lead in April and maintained it to the end of the season, closely followed by *D. fasciatus*. Very few *D. superstitiosus* were recorded.

Aphis.—At no time was Aphis attack severe, although in evidence throughout the season.

Termites.—Certain fields appear to suffer more from termites than others. These were put down to velvet beans and sweet potatoes, with the result that damage, if any, was not noticed.

Mycology.

The season was such that angular leaf spot was expected to be severe, and even Blackarm might have put in an appearance. What actually happened was that angular leaf spot was hardly noticeable, and there was no evidence of Blackarm.

Summary and Conclusions.

Cotton is now established as a permanent crop on account of its reliability in extreme seasons, wet or dry, but stabilisation of prices plays a major part in making it a key crop in the rural economy of the country.

Lack of plant-breeding staff led to a diminution in the amount of selection work that could be accomplished.

The season was too wet to be considered a good one for cotton, but crops turned out better than anticipated.

Excessive stainer damage has resulted in poor quality seed.

A new strain 9L18 issued to certain farmers for bulking did well and those who grew it are impressed with its performance.

Another strain, 9L34, due to follow 9L18 into commercial cultivation, is being nursed for a further year on the Cotton Station.

It is false economy to plant undelinted cotton seed, if sulphuric acid is procurable at a reasonable price.

The effect of jassids, though not more numerous than in former years, was most pronounced, and advantage was taken of the fact to eliminate susceptible strains.

Poor stands reduced the value of yield trials, but these placed the leading strains in the same order as the previous year.

Station crosses of the 7C series again grew tall, rank and leafy. Nevertheless, about one-third have been retained for further observation.

No appreciable damage was suffered from aphis, termites or American bollworm, but Sudan bollworm caused much loss of flowers and young bolls.

Stainers were much in evidence and lowered the quality of lint and seed, especially the latter.

Despite the nature of the season, there was very little angular leaf spot, and no evidence of Blackarm.

ANGLO-EGYPTIAN SUDAN.

PROGRESS REPORT OF THE PLANT BREEDING STATIONS, SEASON 1942-1943

BY

R. R. ANSON, R. L. KNIGHT AND S. H. EVELYN.

INTRODUCTION.

In this report an attempt has been made to outline the various problems that are being dealt with in the three localities in which the Plant Breeding Section is actively engaged—the Gezira, Kordofan Province and Equatoria.

Immediately following this note is a Key explaining the composition of varieties mentioned in symbolic form and the genetic factors involved. It is hoped that this will enable the report to be read more easily.

The Gezira, which is by far the largest cotton-producing area in the Sudan, is divisible into a Northern portion, which grows mainly Domains Sakel, and a Southern portion which grows X1730A—a bushy selection from Domains Sakel.

The main problems in the Northern Gezira have been leaf curl jassid, and to a lesser degree, Blackarm. The climate is dryer than in the South so there is less likelihood of Blackarm disease being spread by wind-blown rain. Domains Sakel, which produces fine lint of high quality, is susceptible to all. Present control measures have lessened the dangers of crop failure, but the fact that these dangers still lurk in the background has necessitated a change of policy. In future greater attention will be given to Domains Sakel and to the work of producing from it high quality selections resistant to jassid, and to Blackarm and leaf curl diseases.

In the South, where rainfall is higher, the possibility of a severe Blackarm outbreak is ever present. X1730A, when once well established, has a tendency to grow away from this disease, but it can by no means be considered resistant. Under Gezira conditions X1730A is resistant to leaf curl.

Control measures of Blackarm disease, which include thorough sweeping up and burning of all debris, seed disinfection with mercurial dusts, and finally a sowing date delayed beyond what is considered the optimum by the Sudan Plantations Syndicate, are costly and wasteful.

Dr. R. L. Knight is directing work at Shambat towards the production of Blackarm-resistant strains of each variety. This work is meeting with success and promising material has been produced containing one factor for resistance ; it will not be complete, however, until at least one and perhaps two more factors for resistance have been added. When this very highly-resistant material has been

produced (it should be available for bulking in 1946–47), it is expected to replace the present susceptible material and thus do away with the need for continuing the costly control measures so necessary under present conditions.

Following on from this, the Egyptian cotton selection work for the Gezira is being carried out at the Research Farm under Mr. S. H. Evelyn's direction, the object being the production of strains resistant to leaf curl with lint of better quality and more uniformity. Mr. Evelyn is also concentrating on dura improvement, and much progress has been made with this very important crop since he took over the breeding work in 1939.

In the Nuba Mountains, and areas where crops are dependent on rain, somewhat different problems are met with.

In these areas, experiments conducted under Mr. R. R. Anson's supervision are being carried out with a view to obtaining, for the Nuba Mountains, an early-maturing, heavy-yielding strain giving a high outturn of good quality lint. A degree of resistance to both Blackarm and jassid is also necessary. Earliness is very essential as the rains are short and because many growers plant their cotton on plains situated a considerable distance from their villages and are dependent on fullahs (dams) for their water supply. When these dry up they are obliged to return to their villages. It follows, therefore, that an early-ripening crop stands most chance of being completely harvested. High ginning outturn is also of importance as, owing to transport difficulties there is at present no sale for the seed.

In Equatoria jassid and Blackarm resistance are of major importance.

It is satisfactory to report that substantial progress has been and is being made in all branches of the work undertaken by the Plant Breeding Section.

Key to Egyptian, Hybrid and American Varieties.

Egyptian Types.

(1) *Domains Sakel—originally imported from Egypt—Main Commercial type.*

(2) *X*1730 (*a bushy type of plant selected from Domains Sakel* (*Family No.* 17, *date* 1930))—

X1730A (Selection from 1730 in 1931 and now grown commercially).
X1730H (A subsequent selection used in backcrossing).
X1730J (A subsequent selection, under trial as improvement).
X1730K (A subsequent selection, under trial as improvement).
X1730L (=BAR.4/1), Blackarm-resistant X1730 under trial.

(3) *N.T.2* (*A selection from Domains Sakel resistant to Leaf Curl*)—

N.T.2/38 (A selection from N.T.2/37 under trial as improvement).
N.T.2/39 (A selection from N.T.2/38 under trial as improvement).
N.T.2/40 (=BAR.2/1) Blackarm-resistant N.T.2.
N.T.2/41 (=BAR.2/7) Blackarm-resistant N.T.2 under trial.
N.T.66/41 (New selection from N.T.66/40, a bushy type itself selected from N.T.2).
N.T.101/41 (New selection from N.T.2 type).

(4) *Blackarm-resistant types*—

BAR.2/1 (5th b.c. N.T.2 homozygous for $\mathbf{B}_2$).
BAR.2/7 (7th b.c. N.T.2 homozygous for $\mathbf{B}_2$).
BAR.2/8 (7th b.c. N.T.2 homozygous for $\mathbf{B}_1$).
BAR.2/9 (7th b.c. N.T.2 homozygous for $\mathbf{B}_1$ and $\mathbf{B}_2$).
BAR.2/10 (9th b.c. N.T.2 homozygous for $\mathbf{B}_2$).
BAR.2/11 (9th b.c. N.T.2 homozygous for $\mathbf{B}_1$).
BAR.4/1 (7th b.c. X1730 homozygous for $\mathbf{B}_2$).
BAR.4/2 (7th b.c. X1730 homozygous for $\mathbf{B}_1$ without $\mathbf{B}_2$).
BAR.4/5 (9th b.c.X1730 homozygous for $\mathbf{B}_2$).
BAR.5/1 (7th b.c. homozygous for R_2^{RS} and $\mathbf{B}_2$).
SUS. 5/2 (7th b.c. homozygous for R_2^{RS} without resistance).
G.12 X1730 (7th b.c. containing neither red factor nor resistance).
G.12 N.T.2 (7th b.c. without resistance factors).
Giza 29 (Karnak) a selection from Egyptian Sakel.

American Hybrids and Straight Selections.

N.T. 15/40 (U.4 × Cambodia) × U.4, single plant selection.
N.T. 43/37 (U.4 × Gambia 14) × U.4, single plant selection.
N.T. 58/39 (Punjab early outcross), single plant selection.
N.T. 69/39 (U.4 × Cambodia) × Jamaica Xerophytic, single plant selection.
S.P. 84 R. (From Uganda).
N.T. 88/40 Acala from Australia.
N.T. 91/40 (U.4 × Cambodia) × U.4, single plant selection.
N.T. 94/40 (U.4 × Jamaica Xerophytic) × U.4, single plant selection.
N.T. 96/40 (57 × Over-the-Top), single plant selection.
X.A.129 (Ex Pump Scheme Strain), single plant selection.
N.T.202/41 (Durango outcross).
N.T.203/41 B.31 from Uganda.
N.T.205/41 (Selected from S.P.20 Uganda), single plant selection.
N.T.207/41 (513 × B.31) × 513. Punjab early × B/A resistant strain.
N.T.208/41 (513 × B.31) × 513. Punjab early × B/A resistant strain.
N.T.210/41 (U.4 × Jamaica Xerophytic) × U.4, single plant selection.
N.T.223/42 (57 × Over-the-Top), single plant selection.
511D (From Uganda SG.85), single plant selection.
511E (From Uganda SG.85), single plant selection.
Deltapine (Foster × Express, from Delta & Pineland Co.), bulk selections.
Pump Scheme Strain : Commercial variety grown in Kordofan.

Key to Genetic Factors Mentioned.

$\mathbf{B}_1$ A dominant weak Blackarm-resistant factor derived from American Upland (Uganda B.31).
$\mathbf{B}_2$ A dominant strong Blackarm-resistant factor derived from American Upland (Uganda B.31).
$\mathbf{B}_3$ A strong partially dominant Blackarm-resistant factor derived from *G. punctatum*.
H. A hairiness factor from Tanguis.
R_2^{RS} A factor governing reddish flowers and leaves from *G. arboreum*.

GEZIRA RESEARCH FARM.

Meteorology.

The total rainfall amounted to 374·2 mm. as compared with 279·3 mm. for last season, and 395·2 mm., the average over the past 24 years.

Weather conditions on the farm were fairly representative of the Central Gezira. A heavy rainstorm some ten days after germination

caused slight waterlogging and concomitant yellowing of seedlings in the lower portions of land occupied by the Standard and Preliminary Varietal Tests, but when drained these quickly recovered.

The total rainfall at the Barakat Seed Farm, most of which fell in July and August, was 315 mm. This was considerably below average and except for 1941 the lowest recorded since 1933.

Cotton Breeding Work (S. H. Evelyn).

A review of the entire Egyptian cotton selection work was made by Anson, Knight and Evelyn this season and the following decisions were reached. (*a*) A large number of progenies were being maintained and carried forward each year in the breeding plot mainly because of inadequate and inaccurate testing. The number prevented intensive analysis of the material and so reduced chances of successful selection. (*b*) Insufficient attention was being given to Domains Sakel—the most important variety in the Sudan. (*c*) Progenies of the X1730 series had not, when tested, proved themselves superior to X1730A and for this reason selection would be mainly confined to the new Blackarm-resistant X1730 strains. (*d*) N.T.2/39, although superior in yield to Domains Sakel, was inferior in lint quality and had not been adopted commercially, even though highly leaf curl-resistant. The Blackarm-resistant N.T.2 strains, especially N.T.2/40, had received very encouraging spinning reports and N.T.2/41, a strain with two further backcrosses to N.T.2/39, was at the bulking stage and material was available for analysis and intensive selection ; this material would accordingly be given priority over N.T.2/39. (*e*) This season the best progenies of the former breeding plot material should be grown and rigidly examined with the object of eliminating the inferior ones and retaining only those of potential promise for testing next season by the Hutchinson Random Progeny Technique. Implementing this policy, 106 progenies (including parent controls) were grown this season and, in addition, bulk plots of X1730L, N.T.2/40 and N.T.2/41. Very careful examination in the field and later in the laboratory has resulted in the elimination of a high percentage of these and the selection of the best for random progeny testing.

Domains Sakel.—The Domains Sakel work was tackled in a different way. At the Barakat Seed Farm a nucleus field of Domains Sakel (D.8.S.F.—the present commercial type), sown with hand-picked seed and rogued three times by the Inspector in charge of the Seed Farm, was examined by Anson, Knight and Evelyn and 268 typical trees chosen at random and the ripe produce harvested separately. Care was taken to see that the selections were not in close proximity to several X1730A rogues which were still present in the field. On the results of halo examinations 14 of the selections were discarded. The remaining 254 selections were analysed for seed weight, lint index, ginning outturn and mean lint length. Relatively high variation occurred in all characters as follows :—

Seed Weight	= 8·8 grms. to 13.8 grms.	General Mean	= 10·8 grms.
Lint Index	= 4·0 „ „ 6·1 „	„ „	= 5·1 „
Ginning Outturn	= 28·2 % „ 35·4 %.	„ „	= 31·8 %.
Lint Length	= 39·4 mm. „ 47·0 mm.	„ „	= 43·9 mm.

Seed Weight :	Only plants with	10·3 grms.	to	11·3 grms.	were selected.		
Lint Index :	„ „ „	4·6 „	„	5·5 „	„	„	
Ginning Outturn :	„ „ „	30·7 %	„	32·9 %	„	„	
Lint Length :	„ „ „	43·0 mm.	„	45·0 mm.	„	„	

In all 43 plants came within these ranges. Five seeds from each were bulked and sent to Shambat as female parent for Blackarm-resistance backcrossing and the remaining seed of each selection will be grown next season in separate progeny lines and the selfed seed of those lines which pass the field and laboratory purity tests will be bulked to form the first nucleus plot of pure Domains Sakel. In addition 14 of the selections, although discarded from the "Purity Group," possessed improved lint characters, particularly in lint index and lint quality, and will be observed in progeny lines next season. Five seeds of each of the original 268 selections have been bulked and will be used as a control.

Hairy X1530 (Jassid-resistant).—Some time ago H. E. King found a plant of X1530 possessing very hairy leaves. Many selections from this have been produced but they segregated for degree of hairiness. In the 1941/42 season two of the selections bred true for hairiness, but possessed very short, coarse lint coupled with a high ginning outturn.

The longest-linted and most hairy plants of these two progenies were carried forward and this season 5 progenies were grown against the X1530 parent control. The progenies all showed high resistance to jassid; the leaves of the control were completely yellowed in contrast. An improvement in both lint length and quality was also observed although with an expected falling-off in ginning outturn. As jassid damage seems likely to become important in the Gezira, 20 progenies are being tested in alternate rows against X1730A next season in a separate experiment, and bulked seed of Hairy X1530 is being tested by the Entomological Section in replicated variety trials at the Farm and in the Northern Gezira.

X1730L.—This season the Blackarm-resistant X1730L occupied a quarter feddan in the breeding plot and a further five feddans at the Farm. Selections were made in both areas. From halo measurements and from the results of the analysis of seed weight, lint index, ginning outturn and lint length, 55 plants were selected for progeny testing next season. Many of these selections show great promise, although character ranges are still wide.

Seed Weight	= 7·6 grms.	to	13·3 grms.	General Mean	=	10·4 grms.
Lint Index	= 4·3 „	„	7·3 „	„	„	= 6·0 „
Ginning Outturn	= 31·6 %	„	42·9 %.	„	„	= 36·5 %.
Lint Length	= 37·2 mm.	„	46·6 mm.	„	„	= 42·7 mm.

Other X1730 Progenies (Blackarm-susceptible).—Seven X1730 and four progenies of each X1730H and X1730K were grown this season against X1730A. The X1730H progenies were discarded after intensive analysis as being inferior to both A and K. Four good selections from each X1730 and X1730K will be given a final test next season against X1730A, as these may be useful as parents in the work of transferring Blackarm-resistance.

N.T.2/40 (Blackarm-resistant N.T.2).—A ¼-feddan area was grown in the Breeding Plot and examined in the same manner as X1730L.

Results of the analysis of the 141 selections showed it to be the same as or inferior to, N.T.2/41 in yield characters, and as N.T.2/41 is the result of two additional backcrosses to N.T.2 it was decided to concentrate on N.T.2/41 and discard N.T.2/40.

N.T.2/41 (*Blackarm-resistant N.T.2*).—From the ¼-feddan area in the Breeding Plot, 182 selections were made and examined in the same manner as X1730L. From these, 54 plants were selected and will be tested in progeny lines against N.T.2/39 next season. The character ranges were as follows :—

Seed Weight	= 9·8 grms. to 14·2 grms.	General Mean	= 12·1 grms.
Lint Index	= 4·0 „ „ 6·4 „	„ „	= 5·3 „
Ginning Outturn	= 26·0 % „ 35·1 %.	„ „	= 30·5 %.
Lint Length	= 40·8 mm. „ 48·6 mm.	„ „	= 45·0 mm.
Mature Bolls	= 10 bolls „ 124 bolls.	„ „	= 42·3 bolls.

N.T.2/38 and N.T.2/39 Progenies (*Blackarm-susceptible*).—Seven N.T.2/38 and four N.T.2/39 progenies were grown and examined. The N.T.2/38 progenies were inferior to N.T.2/39 and were discarded. Ten N.T.2/39 selections were made and will be tested against N.T.2/39 (general), next season. The main object of selecting these is to provide parents for the Blackarm-resistance transference work.

Miscellaneous Progenies (*all Blackarm-susceptible except BAR.898 and BAR.2/4*).—Progeny lines of the following were grown and examined :—(1) N.T.86/39, (1) N.T.56/39, (6) Bushy 30/35, (5) N.T.66, (2) N.T.67/38, (3) N.T.67/39, (2) N.T.36, (4) BAR.898, (4) Sakel from U.S.A., (5) Giza 26, (11) Massey's Domains Sakel (M.D.S.), (1) Commercial Domains Sakel, (1) N.T.2/33, (10) BAR.2/4.

After intensive examination in the field and laboratory it was decided to discard all except 5 plant selections from Bushy 30 35, eight from BAR.898 and ten from M.D.S. The Bushy 30/35 progenies are heavy yielding and possess lint indices of 7 grams and over. The BAR.898 progenies are of Sea Island origin and possess the factor $\mathbf{B_2}$ for Blackarm-resistance. The ten M.D.S. progenies are selected with the object of producing a pure strain of M.D.S. for other experiments on the Farm.

Besides the selections which will be carried forward next season and compared in progeny rows against their respective controls, the following will be tested by the Hutchinson random progeny technique in five-plant plots with tenfold replication :—four Domains Sakel selections and commercial Domains Sakel ; four X1730L and one X1730K selections and commercial X1730A ; four N.T.2/41 and one N.T.2/39 selections and General N.T.2/39, and three of the latest Blackarm-resistant backcrosses.

Selection for Leaf Curl Resistance.

In continuation of this work 18 strains were grown in randomized blocks with eightfold replication. Each plant of each strain was alternated with " Spreader " plants as was done last season and the experiment was sown late on 15th September, 1942. Leaf curl counts were made at fortnightly intervals until 28th April, 1943. No cutting-back was resorted to. The disease first appeared on 25th

November, 1942, in block 5 at the extreme N.E. corner of the experiment. Another diseased plant was recorded on the same date at the N.E. corner of block VII. A plan showing each individual plant was employed to record in different colours the incidence of the disease; the results are given later.

In general, the disease in the experiment was neither as bad nor as widespread as it was in the previous season. Of a total of 5,162 plants, 1,855 or 35·9% were attacked. Of these, 1,573 were "Spreaders" out of a total "Spreader" population of 2,623 (or 60%), and the remaining 282 were R plants out of a total R population of 2,539 (or 11·1%).

The analysis of percentage infection per subplot gave the following results.

Mean % Leaf Curl per Sub-Plot in the Resistant (or R) Strains.

X1730 A, G, H, J and N.T. 102/41	N.T. 97/40, 74/38 and 66/41	N.T. 101/41	N.T. 2/38	N.T. 2/39	L.C.R. 12/41	LEC-REM and X1730	N.T. 100/41	M.D.S. 11/41	M.D.S. 17/41	D.S. "R"	Com. D.S.
Nil	0·74	0·79	1·44	2·28	2·83	2·84	2·88	25·5	38·7	55·4	68·0

* Belts—X1530A=5·7 %; X1530=0·0 %.

Variation due to varieties was significant at the 0·1% level and that due to Blocks significant at the 5% level. Differences of 9·2% infection are significant.

Analysing only strains showing under 3% infection, significance at the 5% level (and nearly at the 1% level) was reached. A significant difference was 2·33%, thus demonstrating the superiority of those strains with no infection. Differences between 0·74% and 2·88% are not significant.

Analysing only strains showing over 25% infection, differences were highly significant at the 0·1% level. M.D.S.1/41, although not differing significantly from its sub-strain (M.D.S.17/41), is significantly more resistant than Resistant Domains Sakel and the Control. M.D.S.17/41 is significantly more resistant than the Control, but differences between Resistant Domains Sakel and the Control did not reach significance.

The following points are worthy of note:—(*a*) The derivatives X.1730A, G, H and J, are more highly-resistant to leaf curl in the Gezira than their original parent, X1730. These strains are as susceptible or more so than Domains Sakel at Shambat. (*b*) The N.T. series tested are all highly-resistant, including N.T.2/38, N.T.2/39 and N.T.97/40, which have been used by Knight as parents in his Blackarm-resistance transference. (*c*) Lecrem, formerly selected by

* The experiment was belted on the East by a row of X1530A and on the West by a row of X1530, both alternated with "Spreaders." X1530A thus occupied the extreme east of Blocks 1 and 5, and X1530 the extreme west of Blocks 4 and 8. Block 1—R=Nil, S=61·1%; Block 5—R=11·1%, S=88·2%; Total—R=5·7%, S=74·3%. Block 4—R=Nil, S=7·7%; Block 8—R=Nil, S=11·1%; Total R=Nil, S=9·7%.

Massey for resistance, has retained the character. (*d*) The formerly alleged fully susceptible Massey's Domains Sakel has shown very definitely its response to selection for resistance. The parents of the two above M.D.S. selections, grown in last season's experiment, had infections of 85·8% and 85·4% respectively. (*e*) The bulk selection of 20 resistant plants from Commercial Domains Sakel last season differs significantly from the Control this season in the main experiment, but the difference of 12·6% infection is not significant when only the M.D.S. and Domains Sakel strains are analysed.

Plants which did not develop the disease in the most heavily infected blocks have been selected and will be tested in a similar layout next season against Commercial Domains Sakel and nine other strains, including the newest Blackarm-resistant families.

The percentage infection of the " Spreaders " (=Bulk of known susceptible M.D.S. plants) was analysed in the same way to determine whether these all belonged to the same population or were affected by being grown between the several varieties tested. Series mean infection varied from 51·7% to 73·8%, but in addition to differences not being significant they bore no relation to the percentage infection of the particular variety between which the " Spreaders " were planted. Thus the " Spreaders " sown between the varieties with no infection had mean infections ranging from 51·7% to 73·6%.

Variation due to blocks was again significant in both the R and S analyses and results support the theory of wind direction spread. Next season plant vigour will be recorded to test whether spread follows the fertility drift.

An analysis of the progress of the disease was made from an individual plant chart and shows the greatest infection to have occurred between March 22nd and April 10th, 1943, *i.e.*, at the very end of the harvesting season for cotton sown mid-August. Here it should be re-stated that the experiment was purposely sown mid-September.

Testing Seed Stocks of Massey's Domains Sakel.

In continuation of this work (reported on page 74 of the E.C.G.C. Progress Reports from Experiment Stations—season 1941–42) the seed produced from the various stocks in the 1941–42 season was grown this season in 5-plant plots in a randomized block layout with tenfold replication. In this manner storage effects were eliminated and differential seed fertility reduced to a minimum as the seed for this season's experiment was a bulking of seed from six subplots of last season's experiment. The experiment was conducted with two main objects : (1) to determine whether natural selection had progressively improved the variety, and (2) to determine whether genetic differences between the seed lots, if present, could be related to yield differences obtained throughout the years 1930 to 1942 in the Observation Plots run by Dr. Crowther of the Plant Physiology Section and sown over this period of years with the seed used in this experiment. Unfortunately

the seed used to sow the 1935–36 Observation Plot had been lost and could not be included.

The origin of the seed for the Observation Plots and subsequently for this experiment is as follows :—

1930/31—Bulk Stock M.D.S. grown at Shambat.
1931/32—New Importation from Egypt—presumably Sakel Strain 310.
1932/33— „ „ Produce of the 1931/32 crop.
1933/34— „ „ „ „ 1932/33 „
1934/35— „ „ Probably „ „ 1933/34 „
1935/36—Bulk stock M.D.S. grown at Shambat.
1936/37—New bulk from Selected Drum plants.
1937/38— „ „ „ (A further generation of bulking.)
1938/39—More of same seed lot of 1937/38.
1939/40—Produce of 1937/38 and 1938/39 Observation Plots.
1940/41— „ series of propagation plots sown with seed of re-selected drum plants.
1941/42— „ Ditto—via one more generation of propagation.
1942/43—Exactly the same as used in 1941/42 season.

It will be noted that fair continuity can only be said to occur from the 1935–36 season. It should here be noted that the Observation Plot is among other things used to indicate the probable yields in the Gezira and its yields have since 1927–28 closely approximated those obtained by the Gezira Scheme after allowance had been made for a progressive improvement in yield in the Observation Plot ascribed to manurial residues. Dr. Crowther contends that the yield fluctuations over these years are mainly due to climatic effects, while the writer has argued that genetic differences must also have influenced annual yield variation.

The mean values of each subplot of 5 plants were analysed for thirteen characters. Variation between plants of any seed lot was in all cases fairly high, but was much reduced between subplots, and so the mean differences between years appear small and do not give a true picture of the heterogeneity which exists within any one year's seed. At Crowther's suggestion the nitrogen content of the various seed stocks used to sow the experiment is being determined to find whether differences, if any, are correlated with character differences, but these data are not yet available.

The analysis showed that progressive improvement through natural selection had not occurred. It is realised that the period of 12 years under review is a short one. Significant differences occur in ten of the thirteen characters analysed, and this fact supports the theory that such differences have probably influenced yield differences in the Observation Plots. When, however, the values of " Seed Cotton per Tree " obtained in this experiment are plotted against those of their respective years from the Observation Plot, some discrepancies occur, which are at present inexplicable and appear to warrant further investigation. As an example, the year 1934–35 possessed the lowest values in eleven of the thirteen characters analysed, yet the Observation Plot of that year gave a significantly higher yield of seed cotton per tree than in any of the former years.

Cotton Varietal Trials (R. R. Anson).

Standard and Subsidiary Varietal Trials were grown in replicated subplots. Six varieties were tested at the Gezira Research Farm,

Barakat and Turabi, and in addition various seed stocks of Domains Sakel were compared at Barakat with the following results :—

Standard Varietal Test at Gezira Research Farm (1942/43).		Varietal Test at Turabi (Northern Gezira) (1942/43).		Varietal Test at Barakat (Central Gezira) (1942/43).	
Strain.	*Lint as % of Domains Sakel.*	*Strain.*	*Lint as % of Domains Sakel.*	*Strain.*	*Lint as % of Domains Sakel.*
X1730A	120	BAR.X1730L ...	124	N.T.2/39... ...	113
X1730J	118	X1730J	123	X1730A	110
N.T.2/39	113	X1730A	122	X1730J	109
BAR.X1730L ...	112	N.T.2/39... ...	117	BAR.N.T.2/41 ...	102
Domains Sakel ...	100	BAR.N.T.2/41 ...	102	BAR.X.1730L ...	100
BAR.N.T.2/41 ...	97	Domains Sakel ...	100	Domains Sakel ...	100
S.E.	±2·03	S.E. ...	±3·2	S.E. ...	±5·42
At P=·05 differences of 6 in the percentages are significant.		At P=·05 differences of 9 in the percentages are significant.		Varietal differences in lint yield did not reach the 5% level of significance.	

Test of Various Seed Stocks of Domains Sakel at Barakat (1942/43).

Strain.	*Lint as % of D.8.S.F.*
F.41	103
Domains Sakel ex Northern Gezira, 1941/42	103
Domains Sakel ex Gash, 1940/41	102
Domains Sakel ex Gash, 1941/42	100
Domains Sakel D.8 S.F.	100
S.E.	±2·2

Varietal differences in lint yield did not reach the 5% level of significance. F.41 was considered less uniform than the others.

Subsidiary Varietal Tests at G.R.F. (1942–43).

A series of X1730 strains and another of N.T.2 strains were tested in separate experiments. The results follow :—

X.1730 Series.		N.T.2 Series.	
Strain.	*Lint as % of X.1730A.*	*Strain.*	*Lint as % of Domains Sakel.*
X1730J	108	N.T.66/41	134
Grade 12 (X1730)	107	N.T.2/38	124
X1730H	107	N.T.101/41	122
BAR.1730L	107	Grade 12 (N.T.2)	120
BAR.4/2	105	N.T.2/39	118
SUS.5/2	102	BAR.2/8	112
X1730K	102	BAR.N.T.2/41	107
X1730A	100	Domains Sakel	100
BAR.5/1	99	BAR.2/9	100
		BAR.N.T.2/40	95
S.E.	±2·83	S.E.	±2·45
Varietal differences in lint yield did not reach the 5% level of significance.		At P=·05 differences of 7 in the percentages are significant.	

Entomology.

Attacks from fleabeetle and termites were light and did little damage. Pink bollworm was more plentiful than usual and damaged about 20% of the bolls.

Mycology.

Blackarm first appeared on 15th October, too late to cause serious damage. Leaf curl appeared about the same time, but there was little spread until right at the end of the season.

General.

The season was particularly favourable to Domains Sakel which gave high yields throughout the Gezira. Selection work on this variety is now included in the programme and should be of the utmost importance.

BAR. X1730L showed a marked increase in ginning outturn over X1730A in practically every locality in which it was tested. This strain is very promising but needs greater Blackarm-resistance by the inclusion of the factor $\mathbf{B}_3$ before serious work to improve it by selection is attempted.

Blackarm-infected seed of X1730L was sown at an earlier date than usual at Fahl Block in the south of the Gezira Scheme. Every twentieth row was sown with susceptible X1730A. After infection was properly established the control rows were unfortunately pulled up, but it was generally agreed that they would have been completely killed off had they been left. Although the X1730L was attacked, it gave a final yield of 5·42 kantars of seed cotton per feddan in spite of the disease being given every advantage.

In an adjacent plot N.T.2/40, also sown early, gave a seed cotton yield of 6·40 k.p.f. and its resistance to Blackarm was very marked.

At Barakat an area of 45 feddans sown with N.T.2/41 gave a seed cotton yield of 7·78 k.p.f.

Spinning tests on these Blackarm-resistant strains are quite promising.

SHAMBAT STATION.

(R. L. KNIGHT).

Introduction.

In May, 1942, the writer toured Uganda for three weeks on duty with a view to studying plant breeding methods in use there, and to obtaining closer co-operation between the plant breeders in Uganda and the Sudan in the production of Blackarm-resistant American types. He welcomes this opportunity of thanking the various members of the Uganda Department of Agriculture with whom he came in contact for their very generous hospitality and the whole-hearted co-operation which they so freely gave.

This season, with the sowing of the first bulk areas of Blackarm-resistant " Sakel " strains in the Gezira, it became possible to give still more attention to other hybrids. A fairly complete collection of wild cotton species was grown and a Blackarm-resistance survey made. Other work continued on established lines with the addition of an investigation on the transferability of high ginning outturn in two American types.

Meteorology.

Rainfall, though unusually heavy (about 9½ inches), was early and very little fell in August though this is normally the wettest month. Temperatures were below normal and there was an exceptionally long cool winter. In the year 1st May, 1942 to 30th April, 1943, there were 204 days when the shade temperature registered 100°F. or over, 38 days with 110°F. or more, and five days with a shade temperature between 115°F. and 117°F.

Genetics and Breeding.

1. *Transference of Blackarm-resistance factors* $\mathbf{B_1}$ *and* $\mathbf{B_2}$ *from Uganda B.31 to Sakel.*

(*a*) *Breeding.*—Both in the X1730 and N.T.2 lines, $\mathbf{B_2B_2}$ plants of 9th backcross origin were crossed with $\mathbf{B_1B_1}$ plants of similar origin. The hybrids, grown out of season, were backcrossed to the $\mathbf{B_1B_1}$ parent. This will give a proportion of plants of $\mathbf{B_1B_1B_2b_2}$ composition which can be rendered homozygous for $\mathbf{B_2}$ by selfing. The aim of this crossing was to obtain 9th backcross material of $\mathbf{B_1B_1B_2B_2}$ type. $\mathbf{B_1}$ and $\mathbf{B_2}$ are both dominant and show weak additive effect ; it was, therefore, less laborious to synthesize the double homozygote by backcrossing to the weaker factor and selfing than it would have been to have selfed it out from a straight F_2.

In 1942–43 winter a start was made towards transferring $\mathbf{B_1}$ and $\mathbf{B_2}$ from BAR.2/11 and BAR.2/10 respectively (both of 9th backcross origin) to Domains Sakel. Crosses between BAR.2/11 and Domains Sakel and between BAR.2/10 and Domains were made and F_1 seed obtained for sowing in 1943 summer.

(*b*) *Bulk Propagation.*

(i) *7th Backcross Material.*—45 acres of N.T.2/41 and 5 acres of X1730L were grown for seed production in the Gezira. The former strain represents 7th backcross material of N.T.2 type homozygous for $\mathbf{B_2}$ and the latter is the X1730 counterpart. It was found that $\mathbf{B_2}$, alone, gave to Sakel a very marked resistance under Gezira conditions, but that a greater resistance would be required to enable the Sudan Plantations Syndicate to forego all other measures of Blackarm control. A plot of X1730L sown in Fahl Block in late July with undusted infected seed, and itself deliberately infected, yielded 5·4 kantars per acre despite a heavy Blackarm attack. The lint from this plot sold at 50 points on X1730A despite the severity of the test of disease resistance for a strain carrying only one resistance gene. To increase the resistance of these types, the *punctatum* gene, $\mathbf{B_3}$, will be added as soon as possible (see later in this Report). Further details of the bulk plots of Blackarm-resistant types grown in the Gezira will be found in the report for the Gezira Research Farm.

(ii) *9th Backcross Material.*—One acre bulk propagation plots of BAR.2/10 and BAR.4/5 were grown and yielded 71lb. and 91 lb. of clean seed respectively, the low yields being due solely to a very heavy attack of pink bollworm (*Platyedra gossypiella*). BAR.2/10 and BAR.4/5 are both of 9th " Sakel " backcross origin and both are homozygous for $\mathbf{B_2}$, the former strain being of N.T.2 type and the latter of X1730 type. The N.T.2 parent used in the synthesis of BAR.2/10 has been re-selected at Shambat for leaf curl resistance for a number of years, and BAR.2/10 thus shows the grade of Blackarm-resistance typical of $\mathbf{B_2}$ with the addition of marked leaf curl-resistance.

Small propagation plots of N.T.2 and X1730 types homozygous for the Blackarm-resistance gene $\mathbf{B_1}$ were also grown.

(iii) *10th Backcross Material.*—Very small X1730 and N.T.2 type plots were sown in 1942–43 winter. These plots were of 10th backcross material homozygous either for $\mathbf{B_2}$ or for $\mathbf{B_1}$.

2. *Transference of the Blackarm-resistance genes* $\mathbf{B_2B_3}$ *from* G. punctatum *to Sakel.*

(*a*) *Genetical.*—Two linked factors with a 32% recombination value have been shown to govern the resistance of the *punctatum* selection FS.2. One of these proved to be $\mathbf{B_2}$; the other factor, $\mathbf{B_3}$, is semi-dominant, giving " 8·1 " resistance when heterozygous and grade " 5·1 "–" 6·1 " when homozygous. This latter factor is likely to be of great value since the combinations $\mathbf{B_3}+\mathbf{B_2}$ and $\mathbf{B_3}+\mathbf{B_1}$ both confer greater resistance on Sakel than $\mathbf{B_1}+\mathbf{B_2}$. (This paragraph originally appeared in the 1941–42 Report but was so mutilated, owing to a typist's error, that it has been repeated here for greater clarity.)

(*b*) *Breeding.*—7th Sakel backcrosses were grown in season and 8th backcrosses out-of-season. These winter-sown backcrosses had the following parentage :—

(1) $(FS.2 \times X1530A) \times X1730F) \times X1730G) \times N.T.2/38^6$
(2) $(FS.2 \times X1530A) \times X1730F) \times X1730G) \times N.T.2/38^3) \times N.T.2/39^3$
(3) $(FS.2 \times X1530A) \times X1730F) \times X1730G) \times X1730H^6$

(As in previous reports, superscripts denote the number of times each strain has been used as a parent. The practice of writing the female parent first has not been followed, it being more convenient to write the donor parent first and successive backcross parents after it.)

Hybrids were made between 7th backcross material containing $\mathbf{B_3}$ (from *punctatum*) and 9th backcross material containing $\mathbf{B_2}$ (from Uganda B.31), both for the X1730 and N.T.2 types. The object of this crossing is to increase the resistance of $\mathbf{B_2B_2}$ types, of proven suitability to Gezira conditions, by the addition of $\mathbf{B_3}$. These hybrids were sown out-of-season and $\mathbf{B_2b_2B_3b_3}$ plants selfed for sowing in 1943 summer.

In addition, crosses were made between 7th backcross material of N.T.2 type, homozygous for $\mathbf{B_3}$, and Domains Sakel as a first step towards transferring $\mathbf{B_3}$ to Domains Sakel. F_1 seed was obtained, for sowing in 1943 summer.

(*c*) *Bulk Propagation.*—Small propagation plots of 6th backcross $\mathbf{B_3B_3}$ N.T.2 were grown to provide seed for test plots. These 6th backcross strains had the following parentage :—

(1) $(FS.2 \times X1530A) \times X1730F) \times X1730G) \times N.T.2/38^4$

(2) $(FS.2 \times X1530A) \times X1730F) \times X1730G) \times N.T.2/38^3) \times N.T.2/39$

In 1942–43 winter small plots of 7th backcross origin were sown but these failed, largely for climatic reasons.

3. *Transference of Blackarm immunity from* G. Sanguineum* (*n=13*) *to New World* (*n=26*) *types.*

In 1942 summer 29 plants of (*Sanguineum* × N.T.2/38) × N.T.2/38 composition were successfully raised. These showed a complete range of Blackarm resistance from grade "3" to grade "12" (full susceptibility="12"; immunity="0") with peaks at grade "8" and grade "12." None of these plants showed fertility as male parents in further backcrossing to N.T.2, but several were partially fertile on the female side and a number of seeds of second backcross composition were produced. A few of these were sown in 1942–43 winter and two plants showing Blackarm resistance were selected for further backcrossing—the other plants were either fully susceptible or else were killed by insect and bird attack before they could be graded.

In the first backcross there were no completely immune plants so that, unless resistance in this cross is only partially dominant, it will not be possible to transfer to Sakel types the full immunity of *Sanguineum*.

4. *Flagging Blackarm-resistant Sakel strains with the* arboreum *gene* R_2^{RS}.

The aim of this line of hybridization is to make Blackarm-resistant strains easy to rogue and keep pure by "flagging" them with a gene conferring reddish flowers and leaves on Sakel.

(*a*) *Bulk Propagation.*—In order to produce seed for test-plots, small propagation plots of 10th backcross material of N.T.2 type, homozygous for the Asiatic gene R_2^{RS}, were grown. These strains, bulked under the reference numbers BAR.6/5 and BAR.6/7, are homozygous for the Blackarm-resistance gene $\mathbf{B_2}$; their exact parentage is given on page 81 of the 1941–42 E.C.G.C. Progress Reports.

On the X1730 side, BAR.5/3, a 9th backcross strain homozygous for both R_2^{RS} and $\mathbf{B_2}$, was bulked.

Finally, at Barakat in the Gezira, a two-acre propagation plot of 7th backcross red-resistant X1730 was grown under the strain reference number BAR.5/1.

* *G. arboreum* v. *neglectum* f. *bengalensis* H. & G.

5. *Production of Blackarm-resistant strains of American Upland for the Southern Sudan.*

(*a*) *Uganda SP.84R.*

The strain reference numbers used in this section are BAR.7/1, SUS.7/2 and BAR.7/3. BAR.7/1 is a type bred by bulking plants in S.P.84R which were homozygous for the Blackarm-resistance gene, $\mathbf{B_2}$; SUS.7/2 represents the Blackarm-susceptible element from S.P.84R (see 1941–42 Report), and BAR.7/3 is a mass selection from BAR.7/1.

(i) *Selection.*—258 plants were taken at random from the bulk propagation plot of BAR.7/1 which was sown in 1942 summer. These were sown, plentifully interspersed with controls of BAR.7/1, as progeny rows in 1942–43 winter. These progeny rows were first examined for lint length and uniformity. Rows showing rather better length than BAR.7/1 were passed, but extreme types and inferior types were discarded. The rows which had passed on lint length were ginned and those with a ginning outturn of less than 37·3% were discarded. (Ginning was done by hand on a 4″ roller gin and this gives a fictitiously high ginning outturn as compared with commercial ginning.) Finally, progenies which had passed both on lint length and on ginning outturn, were examined for " feel " and strength. Fifteen progenies passed all tests and were bulked as BAR.7/3 for test against BAR.7/1 next season.

(ii) *Hybridization.*—The transference, initiated last season, of the Blackarm-resistance factor, $\mathbf{B_3}$, from *punctatum* to SUS.7/2 was continued. The 1st backcross progenies were grown in 1942 summer and the 2nd backcrosses in the following winter, whilst seed of 3rd backcross composition was produced for sowing next season.

The reason for using the susceptible element (SUS.7/2) from Uganda S.P.84R as backcross parent rather than the $\mathbf{B_2}$ element, BAR.7/1, is that the addition of $\mathbf{B_3}$ is thereby made easier. The final $\mathbf{B_3B_3}$ product can readily be crossed with the $\mathbf{B_2B_2}$ type and homozygous lines picked out in F_3.

(iii) *Bulk Propagation.*—About one ton of seed was produced from an isolated 3-acre plot of BAR.7/1, whilst from a small propagation plot of SUS.7/2 enough seed was produced for sowing in the Southern variety trials next season.

(*b*) *Deltapine.*

(i) *Genetical.*—A proportion of Deltapine plants show a certain measure of Blackarm-resistance, the degree of resistance being less than that associated with $\mathbf{B_2}$. Plants of this type were crossed with Sakel and selfbred seed was raised from the F_1. Backcrosses to Sakel were also made and, in addition, the resistant plants were crossed with $\mathbf{B_2B_2}$ Sakel and F_2 seed was produced. This programme of crossing has as its object the genetical identification of the gene, or genes, responsible for the resistance of Deltapine.

(ii) *Hybridization.*—In the transference of $\mathbf{B_2}$ from N.T.61 to Deltapine, the second backcross progenies were grown in 1942–43 winter. Similarly, in transferring the *punctatum* resistance gene, $\mathbf{B_3}$, the 2nd backcross stage was reached and 3rd backcross seed produced.

(*c*) *511D.*

This type already contains $\mathbf{B_2}$. The addition of $\mathbf{B_3}$ was proceeded with and the 2nd backcross was grown in 1942–43 winter.

(*d*) *XA129.*

This Pump Scheme derivative, though fully susceptible to Blackarm, has many characteristics suiting it for growth in the Southern Sudan. $\mathbf{B_2}$ is being added from N.T.61 and the 2nd backcross was sown in 1942–43 winter ; the transference of $\mathbf{B_3}$ was also carried to the 2nd backcross stage. In each case 3rd backcrosses were successfully made.

(*d*) *Uganda BP.52.*—BP.52 is fully susceptible to Blackarm, but, given Blackarm-resistance, it might prove admirable for the Southern Sudan, and even if the resultant resistant type proved unsuited to Equatoria, it would still, presumably, be of value to Uganda. Seed was accordingly brought back from Kawanda and crosses were made between BP.52 and 1st backcross material of XA129 type carrying $\mathbf{B_2}$ and $\mathbf{B_3}$. The F_1s of these crosses were grown in 1942–43 winter and backcrosses to BP.52 were successfully made for sowing next season.

6. *Preliminary Blackarm-resistance Survey of Wild Cottons.*

A number of wild cottons were grown, sprayed with Blackarm and examined for resistance. The results obtained will need confirmation as some of them were from small populations and some were possibly affected by climatic conditions since they were obtained on out-of-season plots :—

(*a*) *Allotetraploid (n=26) types.*

G. tomentosum : fully susceptible.
G. religiosum (Bakatuka) shows a wide range.
G. barbadense (var. Carpulla) : fully susceptible.
G. Darwinii : resistant.

(*b*) *Diploid (n=13) types.*

G. Thurberi : susceptible.
G. Harknessii : Resistant, but contained an off-type fully susceptible plant which later died.
G. Davidsonii : resistant.
G. Stocksii : susceptible.
G. armourianum : resistant.
G. Raimondii : resistant (one plant, only, raised).

No completely immune plant was found in any of the varieties listed above. In this connection it is of interest that *Thespesia populnea* was readily infected with Blackarm and produced symptoms indicating a fair degree of resistance. This is, as far as is known,

the first record of Blackarm on any genus but *Gossypium* for, though it was found by other investigators on *Thurberia thespesioides*, this species was later included in *Gossypium* under the name *G. Thurberi*.

G. Raimondii crossed with Sakel gave two F_1 plants in 1942–43 winter, but both of these proved to be nearly fully susceptible to Blackarm. This may indicate heterozygosity in the *Raimondii* parent or recessiveness. A few more F_1 seeds were obtained for sowing next season when this point can be cleared up.

7. *Pink Bollworm* (Platyedra gossypiella) *resistance.*

Harland, in his book*, notes that "*G. Thurberi* has so far not been attacked, either in Trinidad or Brazil." This cotton, sown at Shambat also showed complete absence of pink bollworm, although surrounding Sakel had a 97% attack. At this stage the surrounding Sakel and American cottons (three acres) were fed off to goats leaving the *Thurberi* almost the only cotton near at hand; the *Thurberi* continued to produce bolls entirely free from bollworm. It is thus probably correct to describe *Thurberi* as immune to pink bollworm under Shambat conditions.

Crosses have been made with Sakel as a first step in determining whether this immunity is governed by a few major genes or by a complex of minor genes. If only a few genes should prove to be involved, transference of immunity to New World types will be attempted.

8. *Jassid resistance.*

(*a*) *Transference of Hairiness from Tanguis to Sakel and American Types.*

The 4th backcrosses were grown in-season and 5th backcross progenies in 1942–43 winter. These families were of the following parentage :—

(1) Tanguis × N.T.2/38[6]
(2) (Tanguis × N.T.2/39) × X1730H[5]

Crossing has been switched to Blackarm-resistant strains of N.T.2 and X1730 now that these are available and in addition, No. 1 (above) has been crossed with Domains Sakel as a first step in transferring the gene **H** (general hairiness) to this type.

On the American side the transference of hairiness to Uganda SP.84R, by backcrossing, was continued. In crosses to Deltapine the Tanguis gene **H** appeared to have become diluted or to have been accidentally lost since no plants in the backcross appeared to be more hairy than Deltapine itself.

(*b*) *Other Types.*

Carpulla, a *barbadense* type from Ecuador sown at the suggestion of Mr. J. B. Hutchinson, looked very promising as a source of hairiness,

* The Genetics of Cotton, p. 144.

being at the start, considerably more hairy than Tanguis. Later in the season, however, the Carpulla became somewhat less hairy and there was little or no difference in degree of hairiness between this strain and Tanguis. Carpulla proved to be more monopodial than Tanguis and flowered too late for it to be possible to grow any winter-sown crosses. Like many *barbadense* types, Carpulla is susceptible to leaf curl.

Four small lots of seed of (Acala Okra × *G. tomentosum*) × U.4 composition were sent to Shambat by Mr. Hutchinson. These proved a useful source of hairiness of a short, dense, velvety type. The most hairy plant in each of these four families was crossed with X.A.129. The F_1s of these crosses will be sown next season.

9. *Ginning Outturn Investigation.*

Deltapine has a ginning outturn of approximately 40%, but has lint of poor spinning quality; X.A.129 has a ginning outturn of about 30%, has lint of good spinning quality, and is well suited to conditions in Equatoria. This line of investigation was, therefore, started to examine the possibility of transferring some, if not all. of the high ginning outturn of Deltapine to X.A.129 without deleteriously affecting the lint of the latter.

Five plants of Deltapine were crossed individually with X.A.129 using a pure bulk of the latter as female parent. Large quantities of F_1 seed were obtained from each of the five crosses. Some of this was sown in 1942–43 winter and each F_1 progeny was backcrossed in bulk to the X.A.120 parent. In addition, two F_1 progenies (Nos. BA.24/43 and BA.25/43) were sown in a replicated test comprising ten random blocks. Each block consisted of four ridges (each of ten holes), being one ridge each of X.A.129, Deltapine, BA.24/43 and BA.25/43. Ginning outturn and seed weight were calculated on all pickings mixed together and the following results were obtained :—

The two F_1 families showed no significant difference from each other in ginning outturn, but both were significantly lower than Deltapine and significantly higher than X.A.129. In seed weight there was no significant difference between Deltapine and the two F_1s, but all three had a significantly higher seed weight than X.A.129. None of the differences in lint length was significant.

The figures obtained in this experiment showed that the high ginning outturn of Deltapine *vis-à-vis* the ginning outturn of X.A.129 shows partial dominance. The differences in seed weight and in lint length are too slight to affect the issue appreciably so that it appears probable that the difference in ginning outturn is due either to (*a*) hair weight or (*b*) hair population or, more probably to both these factors working together. Comparable hair weight figures for Deltapine and X.A.129 are not as yet available, but it is probable that the hair weight per centimetre of the latter is lower than Deltapine. If the difference in ginning outturn proves to be solely a matter of hair weight, this line of work will be stopped, but if density of hair population comes into the picture the possibility of transferring this will be investigated.

10. *Outcrossing.*

In order to obtain an estimate of the maximum percentage of outcrossing to be expected between similar types, numerous single plants of X1730H were sown in a plot of red X1730 (containing the *arboreum* gene R_2^{RS}, see section 4). In the winter-sown bulk progenies of these single plants 15·1% of outcrosses appeared.

11. *Bamia* (Hibiscus esculentus).

(*a*) *Propagation.*—Small propagation plots were grown, as a routine measure, to produce waves of pure seed for further propagation on a commercial scale by the field staff of the Department of Agriculture and Forests.

(*b*) *Outcrossing.*—Single plants of Momtaza bamia were grown in a field of native bamia. Momtaza bamia has smooth pods and the native variety has spiny pods, the latter character being dominant to smooth in crosses. Seed from these single Momtaza plants was grown in progeny rows in 1942–43 winter. The percentage of spiny outcrosses ranged in individual progenies, from 5·8 to 17·7 and the percentage for all the progenies together was 12·0.

12. *Colchicine.*

This drug is unobtainable in the Sudan so an attempt was made to extract it locally. The tubers of *Gloriosa* sp. (*? viridis*) seemed a promising source but a batch of these from Equatoria were found to contain only 0·08% dry weight of colchicine. The analysis was carried out by the Government Chemist.

PUBLICATION.

Knight, R. L.—The Genetics of Blackarm Resistance IV. *Gossypium punctatum* (Sch. & Thon.) crosses. *J. Genet.* (in the press).

SUMMARY AND CONCLUSIONS.

First wave material of N.T.2 type containing the American Blackarm resistance factor $\mathbf{B_2}$ reached the 45 feddan stage in the Gezira this year and yielded 7·78 kantars of seed cotton per feddan.* Enough seed has been sent to the Gash to sow some 1,000 feddans, if the flood is normal, in 1943–44. Meanwhile, both for N.T.2 and X1730 types, the addition of the *G. punctatum* Blackarm-resistance factor $\mathbf{B_3}$ is being speeded up and it is hoped to produce strains of these types containing both $\mathbf{B_2}$ and $\mathbf{B_3}$ within two years.

X1730 strains carrying the Blackarm-resistance factor $\mathbf{B_2}$ and flagged with reddish flowers and leaves (an *arboreum* character) were on test in the Gezira this year. Spinning reports are not yet to hand but it was clear that yield and ginning outturn had not been affected either by $\mathbf{B_2}$ or by the *arboreum* gene.

The transference of Blackarm resistance from *G. Sanguineum* to N.T.2 was successfully carried to the 2nd backcross progeny stage on a small scale.

* 1 feddan=1·038 acres; 1 kantar=315 rotls (=312 lbs.).

About one ton of seed was produced representing the pure breeding Blackarm-resistant component of Uganda SP.84R.

The transference of $\mathbf{B}_2$ and $\mathbf{B}_3$ to X.A.129 and Deltapine, and of $\mathbf{B}_3$ to 511D was continued. The programme this season also included the fully susceptible type, Uganda BP.52.

A Blackarm-resistance survey was made of most of the wild cottons of the world. Since resistance occurs both in Old World and in New World diploids, it is possible that both forms of resistance can together be added to the New World cultivated types.

G. Thurberi, a wild Mexican cotton, has been crossed with Sakel as a first step in examining the possibility of transferring its bollworm immunity.

The transference of hairiness from Tanguis to Sakel types reached the 5th backcross progeny stage and, on the American side, the transference of hairiness to Uganda SP.84R was continued.

A start has been made in investigating the possibility of transferring some or all of the high ginning outturn of Deltapine to X.A.129 without adversely affecting quality.

The percentage of outcrossing in cotton and *Hibiscus esculentus* were found to be 15·1 and 12·0 respectively.

PROGRAMME OF EXPERIMENTS 1943-1944.

All lines of work shown in this Report will be continued.

KADUGLI STATION.

(R. R. ANSON).

Introduction.

Cotton was not planted with anything like the usual enthusiasm. Owing to the difficulty of disposing of the crop, Government decided not to issue seed in some areas; this caused nervousness in areas in which seed was still being issued and rumour was rife throughout that, on account of the war, Government would be unable to purchase the crop. Cultivators hesitated before planting; many planted and weeded their grain crop, then planted cotton as an afterthought. This, and the fact that rains ceased at least one month earlier than usual, accounts for the poor yield of approximately 1·5 kantars per feddan obtained throughout the district.

Meteorology.

The season opened favourably with early and well distributed rains, but unfortunately these ceased very early. Only 71·2 mm. and 27·7 mm. respectively were registered in September and October.

There was no rain after 12th October. The conditions experienced at Kadugli were fairly representative of the whole Province and had a disastrous effect on the main crop (quality was affected almost as much as quantity) the bulk of which was planted well after 25th July and therefore only had 264·5 mm. or less of rain to carry it through to maturity. June plantings fared slightly better but were below average yield. The total rainfall for the year amounted to 671·3 mm., which is below the average.

Breeding, Testing and Propagation.

In all, 69 families of American strains were grown in progeny rows with a control of the commercial variety (Pump Scheme Strain) occupying every tenth row and all edge rows. These 69 families included 48 pure American strains, 10 Trinidad hybrids and 11 American hybrids. Seed planted 24th June germinated well and produced a final stand as good as any so far obtained. Extra seedlings planted on the same date were raised in bottomless tins to supply blank holes.

All families were sprayed 3 times with *Bacterium malvacearum* in suspension. This operation was done between 24–26th August, and grading, by a trained grader from Shambat, was completed some 17 days later (probably this was left rather too long after spraying and a 12-day interval might have been better, as the highly susceptible plants would then have been caught at the peak of infection ; as it was, some had shed their leaves). Nine families graded 6–7, 38 between 8 and 9, and the remaining 22 families were fully susceptible.

Only very outstanding strains will be included in the planting programme for season 1943–44.

Line Tests.—Eleven strains were tested. Six of these showed apparent superiority in yield of seed cotton over controls. Some of the most promising will be tested in the Preliminary Varietal Tests in the coming season. The former system of Line Test layout will be discontinued and in its place a system similar to the one at present in use at the Gezira Research Farm will be adopted.

Preliminary Varietal Test—Kadugli.—This test was made up of five varieties replicated five times. The land on which this was grown is rather low-lying and contains a fair amount of clay, but is typical of certain native cotton-growing areas. The varietal variance did not reach the 5% level for either seed cotton or lint yields.

Standard Varietal Tests.

Kadugli.—N.T.205/41 gave a significantly higher yield of seed cotton than any of the other varieties. Deltapine and N.T.96/40 and P.S. Strain were significantly higher than N.T.58/39. In lint yields, N.T.205/41 was significantly higher than all other varieties,

except Deltapine. Deltapine was higher than the remaining three. N.T.96/40 was significantly higher than P.S. Strain and N.T.58/39. There was no significant difference between the lint yield of N.T.58/39 and Pump Scheme Strain.

Talodi.—In order of yield the strains did not differ appreciably from those in the Kadugli Tests. Varietal variance between seed cotton yields did not reach the 5% level of significance. In lint yields, Deltapine was significantly higher than all other varieties; other differences were not significant.

In the above test Deltapine has again shown up well in lint yield per feddan, but in spinning tests made on the 1941–42 season samples the Shirley Institute found it much inferior to all other cottons tested. The report which accompanied these tests stressed as outstanding features the extremely high strength given by N.T.58/39 and the very low strength of Deltapine samples. The brokers valued N.T.58/39 strain from the Talodi Varietal Test at 9·60d. and from the Kadugli Varietal Test at 9·80d. Deltapine was valued at 9·10d., while Pump Scheme Strain (Control) was valued at 9·25d. for Talodi, 8·85d. for Kadugli, and 8·65d. for the Kadugli commercial sample which was a random sample taken from 1st grade seed cotton delivered at the Kadugli ginning factory, but actually ginned on the small 40-saw gin. Working on brokers' valuations for 1941–42 season lint, and applying these to yields obtained in 1942–43, we get the following cash return per feddan:—

Talodi Standard Varietal Trial, 1942/43.		Kadugli Kamina Varietal Trial, 1942/43.		Talodi Standard Varietal Trial, 1941/42.		Preliminary Variety Trial, Kadugli, 1941/42.	
Strain.	*Cash Return in £ per feddan.*	*Strain*	*Cash Return in £ per feddan.*	*Strain.*	*Cash Return in £ per feddan.*	*Strain.*	*Cash Return in £ per feddan.*
Deltapine ...	8·8	N.T.205/41 ...	9·0	Deltapine ...	19·9	N.T.15/40 ...	5·6
N.T.96/40 ...	7·2	Deltapine ...	8·7	N.T.58/39 ...	15·6	N.T.96/40 ...	5·6
N.T.58/39 ...	7·1	N.T.96/40	7·8	N.T.43/37 ...	14·6	N.T.58/39	5·9
Pump Scheme	6·7	Pump Scheme	6·4	N.T.68/39 ...	15·5	Pump Scheme	4·1
N.T.210/41 ...	6·6	N.T.58/39 ...	6·7	Pump Scheme	14·3	N.T.78/39 ...	4·2
						N.T.91/40 (Belts)	—

Comparison of Deltapine and Pump Scheme Strain in Nuba Mountains.

Plot and Season.	*Yield of lint of Deltapine as % of P.S. Strain.*
1940/41.	
Kadugli Standard	172
Talodi „	166
Means, 1940/41	169
1941/42.	
Kadugli Standard	165
Talodi „	143
Means, 1941/42	154
1942/43.	
Kadugli Standard	138
Talodi „	133
Means of three seasons	153

LINT DATA.

Experiment.	Brokers' Value. Pence per lb.			Effective Length.		Hair Weight.		Maturity.		Highest Standard Count.	
	Delta.	P.S.	Diff.	Delta.	P.S.	Delta.	P.S.	Delta.	P.S.	Delta.	P.S.
1940/41.											
Kadugli Standard	9·25	9·75	−·50	38	40	143	145	+5	−4	26	56
Talodi „ ...	9·50	9·90	−·40	39	37	144	142	+5	+2	25	54
1941/42.											
Talodi Standard ...	9·10	9·25	−·15	40	38	182	173	+27	+31	26	59
Means	—	—	−·35	39	38	156	153	+12	+12	26	56

Ginning Tests.—In comparative ginning tests made during the first week in March, 1943, at Kadugli, with Platt's Air Blast Gins, Deltapine gave an average ginning outturn of 38·1% as compared with 29·1% for Pump Scheme Strain. N.T.83/39 Grade I, 1st and 2nd pickings, gave a ginning outturn of 37·04%, and P.S. Strain commercial cotton, Grade I, at Talodi, a ginning outturn of 27·2%.

Increase Areas.—Small isolation plots of the following strains were grown at Kadugli and elsewhere :—

(1) *N.T.58/42*, a feddan of this selection from N.T.58/39 yielded 6·89 kantars. This strain is under trial in the 1943–44 Varietal tests, and will be planted on a 20-feddan increase area.

(2) *N.T.91/40*, a feddan grown at Kadugli yielded 3 kantars. Further increase areas are being grown in Equatoria, where the strain is included in varietal tests.

(3) *N.T.96/40*, five feddans grown at Lagowa yielded 4·5 kantars per feddan. Increase plots have been arranged for at Lagowa and Dilling.

(4) *N.T.58/39*, twenty feddans yielded 4·5 kantars per feddan. An increase area of 200 feddans has been arranged for at Taxuana.

Bulk Propagation Plots.

Damgamed.—68 feddans were planted with Deltapine and 15 with N.T.83/39, a selection from it. The latter was badly waterlogged and on this account yielded poorly. Heavy and continuous rain made weeding difficult. The final average over the 83 feddans for the two strains was 2·73 kantars which, when compared with last season's yield of 9·6 kantars, is disappointing. Damgamed will be planted with N.T.83/39 in the coming season and the Deltapine seed will sow 3,000 feddans at Miri.

Berdab.—Approximately 700 feddans were planted with Deltapine for seed production. Rains were late and consequently most of this area had not been planted before August 25th, 1942, which in this Province is much too late for cotton. Most growers concentrated on their dura crops and in many instances grass had been allowed to reach from 1 to 3 feet high before any attempt was made to hoe it. The

average yield obtained from the whole area was 3·8 kantars which, under the circumstances, is much more than was to be expected. The average yield for the province was 1·5 kantars. Some of this seed will be used to plant a 3,000-feddan area in the Miri district next season. In the coming season Berdab is to be used solely for the production of dura for export.

Entomology.

Flea beetle (*Podagrica puncticollis*) was very troublesome. Its attack commenced about 6 days after cotton plants had germinated and damage was severe. Probably more so because no cotton had been planted other than that which was sown on the Experimental Farm, and newly-hatched colonies concentrated their attention on a small area. Fine ash sprinkled by hand over cotton seedlings was found to be fairly effective as a deterrent.

Jassid (*Empoasca benedettei*) was not severe until about mid-September when it damaged Deltapine considerably and must have affected yields. N.T.205/41 appeared to be highly resistant.

Bollworm.—Sudan bollworm was more prevalent than usual. Egyptian, American, and pink bollworm attack was normal.

Mycology.

Blackarm made its appearance about mid-August, but it was not severe.

Conclusions.

Notwithstanding the rather disappointing reports received on it from the Shirley Institute, it has been decided to bulk up Deltapine in one area and selection work on it for longer staple continues. Its outstanding yield in lint per feddan warrants further trial. Between two and three thousand feddans will be planted in the coming season.

N.T.205/41 (a single-plant selection from S.P.20 Uganda) appears to carry with it most of the desirable attributes such as Blackarm-resistance, jassid-resistance, earliness and quality, combined with a moderately high ginning outturn and high seed cotton yield. Its propagation is being accelerated and it has been included in all the American Varietal Tests in the soming season.

N.T.58/39 (Punjab early outcross). Continues to show promise and selection work on it continues. An increase area of 200 feddans is being sown at Toxuana and new bulk and progeny selections are being continued with at Kadugli.

N.T.96/40 (57 × Over-the-Top), another promising cotton, is being bulked at Dilling and Lagowa where it enjoys absolute isolation from other cottons.

The abrupt cessation of rain in mid-October greatly reduced yield and caused premature opening of bolls which greatly affected quality and has brought about weak and wasty lint throughout.

The material forwarded for spinning tests will not therefore be up to standard.

The ginning outturn of all varieties tested in the Standard Varietal Test at Kadugli is roughly 3% lower than normal. The drop in lint weight seems to have been consistent as it has affected each variety in the same ratio, except, perhaps, Deltapine, which is usually 6·3% above the control (Pump Scheme Strain).

At Talodi the control has not been affected by the short season as much as other strains appear to have been.

PROGRAMME FOR 1943-44.

The usual Standard Varietal Tests will be planted with 4 varieties replicated 5 times. These will be sited as follows :—

Kordofan—3 at Kadugli, 1 at Talodi, 1 Ummberembeita.

Equatoria—2 at Luluba, 2 at Maridi, and 1 at Kajalu.

Isolated increase areas have been arranged for. Deltapine (New selections) N.T.58/42, N.T.96/40, N.T.91/40, N.T.205/42, N.T.220/42.

Inspection plots of long-stapled varieties have been established at Zeidab.

EQUATÓRIA.

(S. H. EVELYN).

Cotton-growing East of the Nile ceased this year, probably for the duration of the war, but experimental areas continued in order not to lose continuity. On the West no active Government encouragement was given to cultivators to grow cotton and the acreage decreased considerably.

Meteorology.

Rainfall at Maridi and in the Luluba Hills can be described as normal, though less than in the previous season. At Maridi the deficiency was 244·2 millimetres (=$9\frac{3}{4}$ inches), in the Luluba Hills 341·6 millimetres (=$13\frac{2}{3}$ inches).

Variety Trials.

Four sites were chosen at Maridi and four in the Luluba Hills for variety trials, and at Yei a single trial was conducted. At each of the nine sites five varieties, replicated four times, were tested and, except at Yei, early and late sowing and local and extra cultivation (weeding) treatments were superimposed at random on the tests. The subplot size at each site was 0·06857 feddans. An observation plot of ten new promising varieties, together with X.A.129 and S.P.84 was grown in the Luluba Hills. No abnormal conditions occurred at Maridi and Yei,

but at Luluba termites damaged seedlings at Site 1 rather badly, and wild animals caused a certain amount of loss at Site 4. Counts recorded by Knight showed N.T.43/37 to be the best germinating variety at both Maridi and Luluba. In comparison, the percentage germination of 511E, X.A.129, 511D and S.P.84 was only 83·5%, 58·5%, 57·8% and 55·9% respectively, of N.T.43/37. Knight has further recorded some notes which follow later. on the general position of Blackarm disease in this area.

At no site did the seed cotton yields of 511D and S.P.84 differ significantly. Deltapine, except at Site 4, was significantly outyielded by S.P.84, and gave the poorest yields at all sites. Yield differences between S.P.84 and N.T.43/37 were only significant when all sites were treated together.

MEAN YIELD OF LINT IN ROTLS PER SUB-PLOT AT MARIDI (1942/43).

Varieties.	*SITE 1.*		*SITE 2.*		*SITE 3.*		*SITE 4.*		*ALL SITES.*		*Mean Ginning Outturn.*
	Rotls.	*%511D.*	*Rotls.*	*%511D.*	*Rotls.*	*%511D.*	*Rotls.*	*%511D.*	*Rotls.*	*%511D.*	
511D (Control) ...	11·7	100	10·8	100	15·6	100	9·3	100	11·8	100	29·6
S.P.84	11·2	96	11·3	105	18·3	117	10·2	110	12·7	108	31·3
Deltapine	7·2	62	7·9	73	16·1	103	10·6	114	10·4	88	36·1
N.T.43/37... ...	9·5	82	10·0	93	16·3	104	10·1	109	11·5	97	31·1
N.T.58/39... ...	8·9	76	8·8	82	15·1	96	9·1	97	10·5	89	30·3
Significant Difference ...	* 2·40	—	** 1·77	—	* 2·07	—	N.S.	—	*** 1·04	—	—
Coeff. Var. (%) ...	16·0	—	11·7	—	8·24	—	10·0	—	13·0	—	—

Mainly because of its higher ginning outturn S.P.84 generally gave higher lint yields than 511D, though the difference was only significant at one site. S.P.84 also matures slightly earlier than 511D and for these reasons appears to be the best variety for this area. At no site were differences between S.P.84 and N.T.43/37 significant. Deltapine, even with its higher ginning outturn, was generally inferior to the other vareities. Yield differences between N.T.43/37 and N.T.58/39, though always in favour of the former, were not significant.

At Yei S.P.84 significantly outyielded all other varieties in seed cotton. Lint weights were not recorded.

MEAN YIELD OF SEED COTTON IN ROTLS PER SUBJET AT LULUBA (1942/43).

	SITE 1.		*SITE 2.*		*SITE 3.*		*SITE 4.*		*ALL SITES.*	
Varieties.	*Rotls.*	*% X.A.129.*	*Rotls.*	*% X.A.129.*	*Rotls.*	*% X.A.129.*	*Rotls.*	*% X.A.129.*	*Rotls.*	*% X.A.129.*
X.A.129(Control)	40·5	100	24·5	100	16·5	100	13·3	100	23·7	100
511E	47·9	118	31·4	128	22·2	135	18·7	141	30·1	127
S.P.84	50·0	123	27·5	112	25·5	155	20·5	154	30·8	130
Deltapine ...	43·1	106	21·0	86	15·9	96	14·1	106	23·5	99
N.T.43/37 ...	36·4	90	22·3	91	12·3	75	9·9	74	20·2	85
Significant Difference ...	*** 4·79	—	** 4·57	—	*** 3·99	—	*** 3·89	—	*** 2·10	—
Coefficient Variation (%)	7·2	—	11·7	—	14·0	—	16·5	—	11·6	—

At Luluba at all four sites, S.P.84 and 511E, although themselves not differing significantly, gave the highest yield of seed cotton and at two of the sites they significantly outyielded the other varieties.

Their superiority is apparent when all sites are treated together. In yield of lint S.P.84 was generally superior to all other varieties, and N.T.43/37 decidedly inferior. These results justify the replacement of X.A.129 by S.P.84 in this area.

The results of the superimposed cultivation treatments at Maridi and Luluba can be briefly summarised.

On each block at each site the following treatments were superimposed at random :—

EX — Early sown—Extra cultivation (weeding).
EL — „ „ Local „ („).
LX — Late sown—Extra „ („).
LL — „ „ Local „ („).

Treating the four sites at Maridi, irrespective of varieties, the following results were obtained for yield of seed cotton :—

EX	EL	LX	LL
231·4	210·9	156·9	124·0

Treatment variation was significant at the 1% level, a significant difference being 49·3 rotls. Extra cultivation (EX+LX) exceeded Local cultivation (EL+LL) by 161·4 rotls or 36·5%, and Early Sown (EX+EL) exceeded Late Sown (LX+LL) by 53·4 rotls or 13·8%.

The effect of treatments on varieties is best illustrated by comparing the percentage increases in yield of seed cotton over the Late Sown–Local Cultivation treatment. The results indicated that 511D, S.P.84 and N.T.43/37 respond better to extra cultivation and earlier sowing than Deltapine and N.T.58/39, but as only one of each of the treatments occurred at any one site the results must be viewed with caution.

At Luluba the yield of seed cotton with the different treatments was as follows :—

EX	EL	LL	LX
163·4	140·3	116·7	96·6

Treatment variation was significant at the 1% level, a significant difference being 28·4 rotls. Extra Cultivation (EX+LX) exceeded Local Cultivation (EL+LL) by only 3 rotls or 1·2%, and Early Sown (EX+EL) exceeded Late Sown (LX+LL) by 90·4 rotls or 29·8%—a reverse effect to that obtained at Maridi. The effect of treatments on varieties is shown by comparing percentage increases or decreases in seed cotton yield over LL. The results indicated that S.P.84 and Deltapine benefited least from either earlier sowing or extra cultivation. The LX treatment is consistently inferior (though not significantly so) to the control at Luluba and such an unexpected result needs further investigation particularly when, as at Maridi, only a single treatment occurred at any one site.

In conclusion, the results agree that (*a*) S.P.84 is the best variety at Maridi, Yei and Luluba ; (*b*) Extra cultivation is more important

than early sowing at Maridi, than it is at Luluba, where early sowing seems the more important; (*c*) Varieties differ in their response to both cultivation and sowing date treatments.

The Observation Plot at Luluba (1942–43).—The new selections N.T.217/42 and N.T.220/42 of S.P.20 parentages gave yield increases of 72% and 61% respectively over X.A.129 and 41% and 32% respectively over S.P.84. As the strains were not replicated and as the two controls occupied the outside belts of the plot, the results must await confirmation by replicated trials.

The General Position of Blackarm Disease in Equatoria (R. L. KNIGHT).

Primary Blackarm Infection.—There were considerable varietal differences in the amount of primary (seedling) infection due partly to different seed origins, and partly to differences in varietal resistance. At Luluba, on the East Bank, an examination of two variety tests made 6–8 weeks after sowing showed X.A.129 to have by far the largest number of plants infected. SP.84 and Deltapine each showed about a quarter the number, whilst 511E and N.T.43/37 showed respectively a tenth and a twentieth the number. In this connection it is noteworthy that X.A.129 is fully susceptible whereas SP84. contains about 60% of $\mathbf{B_2}$ plants, and that both lots of seed came from the 1941–42 Torit crop. Deltapine shows slight resistance though it does not contain $\mathbf{B_2}$. The seed of this strain came from Damgamed in Kordofan. 511E is resistant by reason of $\mathbf{B_2}$ and N.T.43/37 contains more than 50% of $\mathbf{B_2}$ plants. Seed of 511E came from Maridi in Equatoria and N.T.43/37 came from Kordofan.

The writer has never previously seen Blackarm causing such serious damage to an American variety as was seen on the early sowing date plots of X.A.129 in the second variety test at Luluba.

On the West Bank, at Maridi, counts were made on the variety trials when the plants were in the early cotyledonary stage. The varieties on test were N.T.58/39, SP.84, 511D, Deltapine and N.T.43/37. The last four varieties showed negligible primary infection, but N.T.58/39 showed primary Blackarm in up to 5% of the holes in some of the sub-plots, although seed delinted with sulphuric acid had been used.

Preliminary Work on Blackarm Resistance.—A large number of control types, both American and Sakel, were sown at Maridi and Luluba. These were sprayed with Blackarm suspension and the progress of the disease was watched. It was clear that $\mathbf{B_2}$ provides a very useful degree of resistance under Equatoria conditions. $\mathbf{B_3}$ also appeared to be valuable, but this factor was only available in Sakel types so that its value in American breeding work is still conjectural.

A preliminary investigation of the value of $\mathbf{B_2}$ was made in Luluba district by picking the resistant and the susceptible plants separately in a plot of Uganda SP.84. The results showed that the resistant plants had yielded 14·4% more than the susceptible.

General Note on Blackarm in Equatoria.—Conditions in Equatoria, particularly on the West Bank of the Nile, do not favour a Blackarm epidemic to the same extent as do conditions in Kordofan or in the Gezira during the rains.

This difference between the central cotton areas of the Sudan and the far south is mainly due to climate.

In Torit district (East Bank) cotton is normally sown in June. The average daily maximum temperature in June is 90°F. and the minimum 66·5°F. These respective temperatures fall in July to 87°F. and 66°F., and in August to 87°F. and 65°F. At Maridi (West Bank) the maximum temperatures over the same period are lower. Sowing in the Gezira is mostly done in August. For purposes of comparison, the average maxima and minima for the Research Farm, Medani, are : August 93°F. and 72°F., September 97°F. and 72°F., and October 103·5°F. and 72°F.

The low temperatures in Equatoria greatly increase the incubation period of the disease and plants sprayed with *Bact. malvacearum* at Maridi and Luluba took twice as long to develop symptoms of the diesease as they would have done in the Gezira. This alone greatly reduces the rapidity of spread of the disease in Equatoria. Furthermore, lower temperatures delay germination and give any phage in the soil an added opportunity of destroying the Blackarm bacteria.

In Equatoria, particularly on the West Bank, rainfall is usually more or less vertical and the sweeping " horizontal " rain, which is the general rule in Gezira storms rarely if ever occurs. As a result, the method of spread of Blackarm is seldom by wind-driven rain (the usual spreader in the Gezira) but by surface wash and rainsplash off the ground, as shown by Hansford, Hosking, Stoughton and Yates* in Uganda. Ample confirmation was obtained that surface wash is the main means of spread during the early stages of growth, and a small ridge of earth, sufficient to stop wash from one sub-plot to another in a variety test, was found to check the spread of Blackarm for several weeks.

A secondary effect of the combined climatic factors is the destruction of diseased debris from the previous season's crop. The Equatoria climate favours rapid disintegration of vegetable material by fungi, bacteria and white ants. This destruction appeared to be so effective that no case suggestive of a carry-over of Blackarm infection from a previous crop could be found. Volunteer plants might be expected to carry the disease, but where these grew from wind-blown seed, outside the cotton areas, the growth of tall grass around them acted as an effective screen. Where they grew on an area destined for cotton, they had been cleared with other weeds, before sowing.

* *Annals of Applied Biology*, 1933, 10, pp. 404–420.

An examination of numerous native areas on the West Bank showed that the seed was the main, if not the only, carry-over of the disease. All the areas were sown with 511D, a resistant variety, and the average amount of primary or seed-borne infection found was 0·8%.

As a result of all these factors Blackarm is unlikely ever to cause crop failures in Equatoria (as it has in the past in parts of the Gezira) except in a very occasional exceptional year such as was experienced in Uganda in 1929. Blackarm is, however, always likely to be more serious on the East Bank than on the West and it will probably always be likely to cause sufficient damage to render the growing of resistant varieties a matter of economic necessity.

Breeding and Testing of Dura (*Sorghum spp.*).

(S. H. EVELYN).

The Dura Type Collection.—Forty-three additions were made to the collection and observed in progeny lines. Of these 28 from the Belgian Congo were found much inferior to the commercial types of Equatoria under Gezira conditions. Later on these will be tried out in Equatoria.

A sample seed of one of the new types, obtained in the Upper Nile Province by Mr. O. W. Snow, at Awaj El Bagar, contained what was thought to be a mixture of striped (red and white) grain and self-coloured red grain. When grown separately, the red grain bred true, but each head from the striped grain contained a mixture of red and striped seeds in the proportion of 3 striped to 1 red. As far as is known this is the first observed instance in the Sudan of grain colour segregation in single heads.

The compilation of data on type characters proceeds and for this purpose 113 types were grown and observed this season.

Dura Hybridization.—At the present, although it is considered that straight selection offers better and quicker chances of success, hybridization between a series of commercial types was attempted this season. Because of varying maturation periods, parents of each contemplated cross were sown in alternate holes of the same row, but at different sowing dates to obtain simultaneous flowering. This was not very successful, as in most cases the earlier maturing parent, sown later, grew very slowly and flowered much later than was expected. Pollen kill by hot water treatment was tried, but even at temperatures lower than the 42°C. (111·2°F.), suggested by Stephens and Quinby (1934),* the whole panicle was killed, presumably by stewing, in less than twelve hours from the time of immersion. Because of this failure panicles of parents were tied together and tapped at the time of maximum pollen dehiscence.

* Stephens, J. C. and J. R. Quinby *Reproduction—J. Ag. Res.* (1934), 49 : 2 : 123.

Common Smut (Sphacelotheca sorghi) *Resistance Trials.*—Three hundred odd types of dura were tested by the Plant Pathology Section by infecting the seed with common smut spores prior to sowing. Sixteen types, including the Dwarf White and Yellow Milos and other potential commercial varieties, have not developed the disease in three seasons' trials. This work is being continued.

Variety Trials.—To appreciate the importance of the dura crop in Sudan agriculture the following data are given.—Dura is the main food crop of the country and annually occupies about 60% of the total cultivated area with an estimated annual production of 373,000 tons of grain.

Three-quarters of the crop is produced under rain and more than half the crop is produced by the Blue Nile Province which embraces the Gezira Irrigated Scheme. For these reasons any work of improvement must be mainly directed towards the rain areas of the Blue Nile and Kordofan Provinces and the irrigated area of the former as these areas produce 81% of the total crop. To implement this policy variety trials and/or demonstration plots have been concentrated in these areas and similar trials, though to a lesser degree, are being conducted in the Kassala, Northern and Equatoria Provinces.

Rain Areas.

(*a*) *Blue Nile Province.*—This season trials were arranged for at Rufaa, Qundal and Managil, but the rains were sub-normal and so localised that the tests at Rufaa and Qundal failed and that at Managil could not be sown.

An adjoining area to the North of the Gezira Research Farm which had been under continuous " rain " dura for a long period of years was taken over for rain trials and prepared in the local manner. Eight varieties, in eightfold replication, were tested in a randomized block layout and eighteen others of potential merit were observed in unreplicated plots. The experiments were sown on the day (23rd July) the Native cultivators sowed the surrounding area, *i.e.*, after the land had received a cumulative total of about 3 inches of rain. Germination was excellent and growth in the early stages good, but it was noticed that the dwarf varieties developed slowly. The *Striga* root parasite, *Striga hermontheca*, appeared early but was controlled by hand pulling. The rains fell off at end of August and the dura, especially the Dwarf varieties, was immediately attacked by mealy bug which caused severe loss of yield by stunting and death. Subsequently Andat bugs and grasshoppers caused further reduction in yield. The trials were reaped on 26th October, 96 days after sowing. Because of the loss of stand occasioned by mealy bug attack the covariance between stand and yield was analysed and found highly significant. For this reason grain yields were adjusted. As was expected, El Galaa, Feterita 1931 and Feterita Maatuk significantly outyielded the dwarf

varieties and the semi-dwarf Qundal Feterita in dried gassab (=stem and leaves). The test will be repeated.

In the "Observation Plot" seven of the eighteen varieties gave promising results and merit further trial.

(*b*) *Kordofan Province.*—In continuation of the work reported last season, 82 varieties were observed in unreplicated plots at Dilling (3rd season), Kadugli (2nd season), and Talodi (3rd season), through the kind co-operation of Mr. Anson and the Inspectors of Agriculture stationed at these sites. Excellent results were obtained at Dilling and Kadugli, but the data from Talodi seriously conflicted with the 1940 results. Nevertheless, the results have permitted the selection of the best varieties for replicated trials next season, as many of these have consistently given excellent yields over a period of two or three years under varying climatic conditions and are earlier maturing than many of those in general cultivation. Thus, at Dilling 25 varieties have given mean grain yields over three seasons of 1,000–1,900 rotls per feddan, and at Talodi 15 varieties have yielded 800–1,200 rotls per feddan. At Kadugli the mean yield for two seasons from 20 varieties has been 1,000–1,650 rotls per feddan, and these yields are coupled with maturation periods of four or five weeks less than many of the main local varieties. Next season the best varieties at each station will be grown in replicated trials in their separate maturation groups and compared with the local commercial types.

(*c*) *Equatoria Province.*—This season a replicated trial was conducted at Maridi through the kind co-operation of the Inspector of Agriculture, and unreplicated observation plots of 40 varieties were grown at Maridi and Amadi on the West Bank of the Nile, and at Torit and Luluba on the East Bank. Seven varieties in eightfold replication were tested at Maridi against Vunde—the local type. Unfortunately individual subplot yields were not recorded and so the results could not be analysed statistically. Again, Vunde dura is very late maturing and apparently had not flowered at the time of harvest of the other varieties—which took 106–126 days to mature. Bangitbar —a Kordofan type—gave impressive results in both the replicated and unreplicated trials and was much favoured by the local cultivators. Many of the introduced varieties in the Observation Plot also gave promising results and further tests will be conducted. Unfortunately no results were received from Amadi and Torit, and at Luluba, through an error, the demonstration plot was sown in April instead of June/July and was a complete failure owing to lack of rain.

Irrigated Areas.

(*a*) *Blue Nile Province.*—At the Research Farm 14 varieties in eightfold replication were tested. Unfortunately very heavy rains immediately after watering, flooded the trial and necessitated artificial baling by pump. This was repeated three times within the first month and seriously affected germination and early growth, necessitating a heavy resow when the plot was sufficiently dry. However, a final

mean stand of 90% was achieved, and dried grain and gassab yield differences were highly significant. Dwarf White Milo, with a mean grain yield of 1,500 rotls per feddan, again significantly outyielded twelve of the varieties, but the difference of 200 rotls per feddan between it and Managil Feterita was not significant. Feterita 1931, the control, was significantly beaten by these two varieties. As expected, the later-maturing varieties, including the control, significantly outyielded the dwarf varieties in gassab yield.

At Abdel Magid the local Feterita was tested against seven other varieties in four-fold replication. Dwarf White Milo significantly outyielded the control by 23% in grain yield and produced 4% more gassab, though this figure is not significant. The grain yield of the Dwarf White Milo was 2,570 rotls per feddan against that of the control of 2,090 rotls per feddan. The estimated average yield of the local main crop was 1,109 rotls per feddan, which was considered poor. Demonstration areas of Dwarf White Milo (6 feddans), Dwarf Hegari (6 feddans), and Feterita 1931 (3 feddans) yielded at the rate of 2,959, 2,194 and 1,285 rotls per feddan respectively.

Tests similar to those at Abdel Magid were carried out at Fatisa, Hashaba, Ed Dueim and Umm Gerr on the White Nile.

At Fatisa an unrepresentative plot of land was chosen. This had been under rain cultivation for a number of years and thus received its first irrigation. Green grain yields ranged from Feterita Maatuk at 3,047 rotls per feddan to Dwarf Feterita at 2,156 rotls per feddan. Differences between the grain and gassab yield of the control, Feterita Maatuk and Dwarf White Milo were not significant. Main crop Feterita averaged 1,850 rotls per feddan.

At Hashaba, Feterita Maatuk again came first in grain yield, but did not differ significantly from the control, although the latter significantly outyielded Dwarf White Milo. The last named variety was handicapped by the malicious removal of 78 holes of one of the subplots. In gassab yield there was no significant differences between Feterita Maatuk, Dwarf White Milo and the control.

At Ed Dueim the labels from the subplots were unfortunately mixed and the data are not reliable. Only Dwarf White Milo and Dwarf Hegari could be segregated with accuracy, and in grain yield per subplot Dwarf White Milo significantly outyielded all others.

At Umm Gerr the test was sited next to a wood surrounding the Rest House and with the exception of Dwarf White Milo was completely destroyed by birds. The work is being continued.

In the Gezira Scheme demonstration plots of Dwarf Hegari gave promising results, but this variety, except in a few instances, is not well favoured by the cultivators.

(*b*) *Northern Province.*—At Shendi, the varietal trial was converted into a Sowing Date Experiment, which was destroyed by stemborer. A further trial will be grown next season.

Flood Trials.

(*a*) *Kassala Province.*—At Tokar 31 varieties were grown in unreplicated plots for observation, through the kind co-operation of the Inspector of Agriculture. Many of the new varieties gave high yields and appeared very promising and this work is being continued here, and in the Gash, and at Tessenei just within the Eritrean border.

Future Work.

All branches of the work reported will be continued and, in addition, variety trials will be conducted next season in the Gezira Scheme at Kab El Gidad (North), Barakat (centre), and Hag Abdulla (South). Five- or ten-feddan Demonstration Areas of Dwarf White Milo will be grown against the local type at each of the 39 Syndicate Blocks.

[*Included by courtesy of the Uganda Government.*]

UGANDA.

COTTON EXPERIMENT STATIONS, KAWANDA AND SERERE, PROGRESS REPORTS FOR THE SEASON 1942-43.

KAWANDA ZONE

BY

C. G. HANSFORD

Senior Plant Pathologist.

In the absence of other staff the writer was in charge of the cotton breeding work at Kawanda during the past season.

METEOROLOGY.

RAINFALL DURING 1942–43 COTTON SEASON.

	1942–43.	*Mean* 1936–41.
March, 1942	8·00	3·29
April	8·93	7·27
May	6·20	5·57
June	3·04	2·62
July	1·04	2·07
August	6·51	2·86
September	3·98	4·15
October	2·52	4·62
November	2·24	5·45
December	3·89	4·07
January, 1943	0·71	2·28
February	3·11	2·88
TOTAL	50·17	47·13

The two months March and April, prior to the planting of cotton in May, were exceptionally wet, as was August, but the period September to January was abnormally dry and picking was practically completed before the February showers. On the whole the season was fair and much less immature cotton was present in the crop than in the previous season, which was marked by continued heavy rain throughout the picking period.

COTTON VARIETIES.

BP.52.—This is now the standard variety of the Kawanda Zone, and has fair to good yield, approximately equivalent to that of the old " Buganda Local " which it has replaced ; the lint has a staple length of 31–32 mm. and a ginning percentage of about 31. Its chief defects are poor resistance to Blackarm and rather low resistance to *Verticillium* wilt disease. Unfortunately at the moment all our stocks of this variety are contaminated with naked and half-naked seed types, probably from mixture or crossing with Buganda Local, which during the period 1927–1937 showed great deterioration in ginning percentage and in lint length owing to the rapid increase of these same seed types within it. For this reason the present position of BP.52 is somewhat

alarming, and during the past season an attempt was made to return to the original stocks of this variety kept as museum specimens in the laboratory. A quarter-acre planted with the most recent of these samples was examined plant by plant :—40% of plants had lint below 30·5 mm., and 7% had naked seed or seed with green fuzz.

This sample thus shows serious contamination, and further work is urgently required on the re-purification of BP.52, with a view to replacement of all stocks throughout the area where it is now grown. Bulk samples from the 1941–42 crop of the Kawanda Seed Farm showed 1·5% seed impurity, which was removed by hand picking ; the 1942–43 crop from this seed has given a seed impurity of 2·5%, which is again being removed by hand picking prior to planting on the Seed Farm during the 1943–44 season.

Buganda Local.—The large-scale cultivation of this is now being abandoned and little attention was paid to selection from it, beyond the final examination of the seed types isolated during recent years. At the close of the 1941–42 season the progenies in existence were examined plant by plant and all those not breeding pure for the character desired were discarded. The remaining fuzzy types, designated " Heavy White," " Normal White " and " Green," were bulked and planted. During 1942–43 these were sprayed with Blackarm cultures and the most susceptible plants removed, as well as all those infected with wilt disease. At the close of the season not a single plant was found to approach the standards of lint length and ginning percentage required, and all were abandoned. In view of the lack of result from twelve years' selection work on this variety, it has now been decided to abandon this line completely.

Kawanda Hybrid Cottons.

A visit by Mr. R. L. Knight, of the Sudan, resulted in a critical review of the whole programme of cotton hybridisation at Kawanda and its reduction to lines considered of primary importance and likely to lead to results of commercial value ; a few secondary lines of work are still being carried on, but reduced to a bare minimum. In this way the programme has been adapted to the improvement of our standard variety, BP.52, in resistance to Blackarm and to wilt disease, by the adoption of the Sudan technique of repeated backcrossing. Unfortunately the breeding plots had already been planted at the time of Mr. Knight's visit, so that the past season's work has been somewhat of a compromise to utilise to the best advantage the material the plots then contained.

1. *Hybrids of BP.52 and B.181.*—The B.181 parent in these was originally isolated from Buganda Local, and has many good points, especially high yield, ginning percentage 32–34%, high resistance to both Blackarm and to wilt, but it has lint markedly inferior to that of BP.52. Line selections from B.181 have shown little improvement in lint characters, and where long-linted strains have been isolated they have suffered from reduction in ginning percentage and are still well below the BP.52 standard of quality.

The hybrids BX.25 (BP.52 male × B.181 female) and BX.34 (B.181 male × BP.52 female) were originally made with the object of combining the desirable characters of both parents. They are not true reciprocal hybrids, as they were originally made from different individual plants of not very pure varieties. In habit and general appearance, as well as in lint characters, the BX.25 series shows a close approximation to its female parent, B.181, but BX.34 shows more evidence of its female parent, BP.52, though throwing many types similar to B.181. These original hybrids have been carried through successive generations and are now in F_6; a number of single plants have been isolated from time to time and bulked as separate strains.

During the past season all strains of these two series were sprayed repeatedly with a suspension of Blackarm-infected leaves and were selected very rigidly against more than a mere trace of infection, as well as against wilt infection, though in the latter case it was not possible to prepare cultures of the disease in sufficient bulk to carry out wholesale inoculation.

At the close of the season all plants remaining were examined for lint length and all those with lint below 30 mm. were discarded. All selected plants were kept separate for a final test of resistance to disease and of lint characters during the coming season. Among the bulks of the BX.25 group the final Blackarm counts showed susceptibility of 50 to 94%, and from 3 to 20% of the plants were infected with wilt at the close of the season. In all, from a total of 4,000 plants only 71 selections were made. The BX.34 series showed Blackarm susceptibility varying from 54 to 92% and wilt susceptibility of 19 to 50%; from a total of 2,100 plants a total of 60 final selections was made.

2. *Backcrosses to B.181.*—Four separate groups of first backcrosses were available and two of second backcrosses. These were treated in a manner similar to that detailed above for the simple hybrids. Of the first backcrosses, the BC.5 group showed susceptibility to Blackarm varying from 34 to 100% in different selections, and wilt incidence of 10 to 60%; from 2,200 plants only 11 final selections were made. BC.5 was originally made by backcrossing BX.34 female with B.181 male. The next group, derived from BC.7, made by backcrossing BX.25 male to B.181 female, showed amongst its derivatives a Blackarm susceptibility of 63 to 73%, and wilt incidence of 6 to 27%; from a total population of 880 plants 30 final selections were made. The third of the groups of the first backcrosses was derived from BC.11, which was made by backcrossing BX.34 female to B.181 male; the Blackarm susceptibility varied from 93 to 100% and wilt incidence from 6 to 34%; from a total of 1,500 plants only 8 final selections were made. BC.18 is the last of this group of first backcrosses, and the F_3 was grown during the past season; it showed 96% of plants susceptible to Blackarm and 2% of natural wilt infection; only 3 selections were made from 290 plants.

The second backcrosses, BC.33 and BC.45, were grown, and treated as above. BC.33 group showed Blackarm susceptibility of 78 to 100%, and wilt incidence of 4 to 6% ; from a total of 800 plants only 16 selections were made. BC.45 was grown as an F_2 from the original backcross ; Blackarm susceptibility amounted to 81% and 1% of plants were infected with wilt ; out of 280 plants 8 final selections were made at the close of the season.

No further backcrossing to B.181 was done during the season, as it was considered necessary first to examine the progenies available for the characters required ; unless the progenies of the final selections show lint characters approaching those of BP.52 during the coming season, the whole of this material will be discarded, as from it we cannot obtain the transfer of BP.52 lint to B.181.

3. *Backcrosses to BP.52.*—In this line of work we are attempting to transfer resistance to Blackarm and possibly also to *Verticillium* wilt from B.181 to BP.52 ; if at the same time we can also transfer the high yielding characters of B.181, so much the better. The only first backcross available was BC.6, in the form of selections from the F_1, which had reached F_4 or F_5 stages. Of these BC.6.8 was available only in very small quantity and was bulked for further work next season. BC.6.14 showed 85% of plants susceptible to Blackarm and 48% with natural infection by wilt disease ; the remaining plants were sorted for lint above 30·5 mm. and a bulk selection made for increase to test the agricultural and lint characters against those of the two parents next season. The mean ginning percentage of the selected bulk was 32·5%, rather higher than that of BP.52. Eight final selections were made from BC.6.14.A4, which showed Blackarm susceptibility of 92% and wilt incidence of 53% during the season.

The second backcross, BC.34, gave 87% infection with Blackarm and 2% with wilt disease during the season ; five plants were selected for production of the third backcross BC.66.

4. *Hybrids of Mexican Big Boll and BP.52.*—These were originally made with the object of raising the ginning percentage of BP.52. The F_2 of the reciprocal hybrids was grown at Kawanda during the past season ; all plants were attacked rather severely by Blackarm, and natural infection with wilt disease amounted to 24%. For further investigation a number of single plants were selected for high ginning percentage combined with lint of over 29·5 mm.

5. *Hybrids of BP.52 and Delfos 4.*—The F_2 of the reciprocal hybrids was grown in 1942–43 ; all plants were susceptible to Blackarm and natural wilt infection occurred in all lines of the progenies. From a total of 415 plants 73 were selected as having promising lint combined with higher ginning percentage than BP.52. On the whole this cross appears more promising than that with Mexican Big Boll.

6. *Hybrids of BP.52 and Gambia Native.*—The latter is being used as a source of Blackarm resistance alternative to B.181 ; during the past season the first backcross to BP.52 was sorted for resistance and

the selected plants again backcrossed. An attempt to make the third backcross towards the end of the season was defeated by the continued dry weather which prevented normal growth and flowering of the plots planted in September and October.

7. *Hybrids of BP.52 and Tanguis.*—Tanguis is reputed to be very resistant to wilt disease in Peru and California; our Uganda stocks came from the latter place. The F_2 of the hybrid BP.52 female × Tanguis male was grown at Kawanda during 1942–43; the whole progeny, like that of the F_1 the previous season, was predominantly of Tanguis habit, erect, with long internodes and large flowers. Segregation was observed for all vegetative characters noticed, such as height of plant, length of internode, length of petiole, leaf shape, flower colour, petal spot, hairiness, etc. No attempt was made to analyse for these characters, which are of no importance to Uganda, the only character desired being resistance to wilt. Out of a total population of 463 plants at the end of the season only 3 showed wilt infection, in spite of heavy inoculation through the soil. Many were rogued out as of poor type and 44 separate plants were backcrossed to BP.52. Out of 84 plants examined in detail at the close of the season 48 had heavy-fuzzy seeds, 31 sparse fuzzy and 5 naked with tuft; while 67 had green fuzz and 17 white fuzz. Lint lengths varied from 26·6 to 42·9 mm.; ginning percentage from 25 to 40. A few plants showed combination of lint length and ginning percentage well above the usual Uganda standards, and seem worth further investigation from this standpoint. The whole progeny was very susceptible to Blackarm. The F_1 generation of the previous season had lint 34–39 mm., ginning percentage 28–33 and all full green fuzzy seeds.

8. *Hybrids of Tanguis and B.181.*

(*a*) *Tanguis female* × *B.181 male.*

F_1 of Tanguis habit; lint 26 mm., ginning percentage 37, full green fuzzy seed.

F_2, predominantly of B.181 habit, but segregating for stem colour, hairiness, leaf shape, size and colour of flowers, petal spot, etc. The seeds of the 59 plants selected were brown fuzz 33, white fuzz 20, green fuzz 6, all with full fuzz. Lint length varied from 17–29 mm. and ginning percentage 33–44. Wilt amounted to 6% after inoculation of each plant through the soil.

(*b*) *B.181 female* × *Tanguis male.*

The F_1 grown in 1941–42 was all of Tanguis habit, with lint 31–37 mm., full green fuzzy seed and ginning percentage 32 to 35.

The F_2 grown 1942–43 was of predominantly Tanguis habit, segregating for the vegetative characters mentioned above. Out of a total population of 670 plants, in September 25% were removed for severe Blackarm infection, and finally 64 plants were selected for backcrossing to B.181. Of these 8 showed wilt infection at the end of the season, after inoculation of all plants. Seed types were 35 heavy

fuzz, 25 sparse fuzz, 4 naked with tuft ; also 51 green fuzz, 13 white fuzz. Lint length varied from 26 to 38 mm., and ginning percentage from 28 to 40. For further work 32 separate progenies were retained from the first backcross.

9. *Notes on Miscellaneous Hybrids at Kawanda.*—In the twelve plants grown of the first backcross from Hopi to BP.52, the fine lint of the former was completely dominant ; lint length varied from 28 to 31·5 mm. and ginning percentage from 29 to 32. A second backcross to BP.52 was made during the season.

Natural wilt infection was found in all F_1 progenies of hybrids between Uganda varieties and Giza 27, as well as those of Pima ; all lines of the F_2 generation showed similar infection. It is thus evident that neither Giza 27 nor Pima contains genes for resistance to *Verticillium Dahliæ*, though the former is resistant to *Fusarium* wilt in Egypt. No further work on these hybrids is proposed.

The F_1 generation of four hybrids between *Gossypium tomentosum* and Uganda varieties was grown during the past season. All had a velvety appearance of stem and leaves, due to a very dense layer of short hairs ; all plants showed susceptibility to Blackarm, though the hybrid with SP.84 (a U.4 derivative) was only slightly attacked. The areolate mildew, *Cercosporella Gossypii*, was very severe on all plants during the dry weather of December and January, though the effect on the plants appeared to be negligible. All four hybrids were exceedingly prolific. In seed characters the hybrid with SP.84 was quite distinct from the others, having seed with pure white short full fuzz and white lint 24–30 mm. long. The other hybrids with BP.52, B.181 and BP.50 had seed with pale green, very long (up to 5 mm.) silky fuzz and pale brownish silky lint, very strong, 23–26 mm. in length and rather strongly adherent to the seed coat. The F_1 plants are being backcrossed to their Uganda parents, while an F_2 generation is being grown to see how the characters segregate.

Variety Trials.

Kawanda Main Variety Trial.—This consisted of a three-fold lattice of 25 varieties, planted on May 25th, 1942, at 3′ × 1′ spacing.

Varieties : Buganda Local Group :—LM.1 : selfed seed from a bulk made in 1941 after removal of naked and green seed. *S.1307 :* a Serere selection.

N.17 Group :—Three Serere selections, S.1103, S.2102 and S.2116.

BP.52 Group :—BP.52 bulk and S.2206, a Serere selection.

BP.50 Group :—X5 a mixture of line selections.

B.181 Group :—B.181 Bulk ; KP.31, KP.39 and KS.2, selections ; X4, mixed selections.

Hybrids of BP.52 and B.181 :—BX.25 and BX.34 ; X3 is the 4th generation from a mixture of BP.52 and B.181.

First Backcrosses to B.181 from BP.52 :—BC.5, BC.7 and and BC.11.

First Backcross to BP.52 from B.181 :—BC.6.

Variety.	Total Yield per acre.	Ginning Percentage.	Lint per acre : 1st Quality. lb.	Lint Length. mm.
LM.1	1,416	30·0	384	29·5
S.1307	1,658	34·6	525	26·7
S.1103	1,404	29·8	386	29·3
S.2102	1,254	31·1	346	29·0
S.2116	1,198	32·7	365	29·3
BP.52	1,176	30·8	342	31·5
S.2206	1,206	32·2	366	30·0
X5	1,160	29·7	323	31·7
B.181	1,598	32·5	501	30·4
KP.31	1,596	31·1	473	31·8*
KP.39	1,451	31·4	441	30·8
KS.2	1,480	31·0	435	32·5*
X4	1,514	30·4	428	32·0*
X3	1,375	32·2	405	31·0
BX.25	1,629	30·7	463	32·1†
BX.25.18	1,570	31·8	460	31·5†
BX.25.62	1,697	31·0	486	31·9†
BX.34	1,500	32·0	456	30·7
BX.34.50	1,601	30·7	476	31·5†
BC.5	1,486	34·1	491	30·3
BC.7	1,386	32·5	430	30·6
BC.7.12	1,350	31·9	410	30·6
BC.11.1	1,541	33·0	479	31·9†
BC.6.14	1,395	33·0	442	30·7
BC.6.14.A4	1,217	33·1	371	30·9
L.S.D.	195	0·8	56	1·1

NOTES : * These varieties contained much immature lint, hence the values for lint length are somewhat fictitious.
† These hybrids segregated for lint length, throwing short types ; the measurements given are those of the longer types.

District Variety Trials.—These consisted of a 4 × 4 Latin Square at each of eleven centres ; the varieties used were LM.1, BP.52, B.181 and X5, the same as the preceding season :—

Centre.	Total Seed Cotton per acre (lb.).				
	BP.52.	B.181.	X3.	LM.1.	L.S.D.
Kawanda	1,189	1,344	1,312	1,132	—
Bukalasa	1,450	1,372	1,524	1,453	—
Kalagala	1,472	1,856	1,831	1,825	258
Nakifuma	1,064	1,115	1,227	1,055	124
Mukono	653	515	541	689	—
Bukomero	1,665	2,153	1,935	1,704	348
Nkozi	541	508	598	629	—
Kalungu	276	369	280	228	—
Kyanamukaka	667	501	726	1,025	295
Kabasanda	1,278	1,254	1,198	1,451	—
Kyenjojo	350	353	404	434	52
Means	992	1,046	1,071	1,045	—
Means—1941–42 / 1942–43	1,111	1,189	1,190	1,096	32

Seven trials were tested for ginning percentage :—

Variety Means : BP.52 ... ... 31·7
B.181 ... ... 32·4
X3 ... ... 32·1
LM.1 ... ... 29·7

INCREASE PLOTS.

(1) The variety BP.213, a selection from B.181, was increased to the 3-acre stage to obtain samples of lint for commercial report ; the average yield was 806 lb. per acre.

(2) The 20-acre increase stage at Kawanda was utilised for B.181, and yielded 965 lb. per acre of seed cotton. The seed from this has been despatched to Teso for distribution there, and the same area will be re-supplied from the 20-acre stage at Kawanda next season.

(3) The Kawanda Seed Farm was planted with BP.52, the seed having first been sorted by hand to remove impurity. The total crop production from 197 acres planted was 103,581 lb., an average of 525 lb. per acre. The ginning percentage of the crop was 30·8 for first quality cotton.

Summary.

1. The season was particularly wet in the early months, but these were followed by a long dry period, September to January.
2. Our standard variety BP.52 is seriously contaminated, and steps are being taken to re-purify this strain for later distributions throughout the western half of Uganda.
3. Cotton breeding has been designed primarily towards the improvement of BP.52 in relation to Blackarm disease. Secondary lines of work are the search for heritable resistance to *Verticillium* wilt disease and its transference to BP.52.
4. The possibility of raising the ginning percentage of BP.52 by hybridisation with Mexican Big Boll or with Delfos 4 is under investigation.
5. These lines of work will be continued through the 1943–44 season.

SERERE ZONE

BY

J. D. JAMESON.

Introduction.

The programme was recast to provide for two definite changes in outlook. Single-plant selection in cotton gave place to a planned attack on certain problems, notably Blackarm, from the standpoint of genetics ; and clearer recognition was given to the relative value of basic agricultural considerations and their bearing on the physiology of the cotton plant in the field. A miniature NPK experiment on classical lines was started to give the necessary background for the latter.

Meteorology.

The total rainfall in 1942 was 57·37 inches, the average for 21 years being 53·94 inches. The distribution was very unusual. High records were established in April, May and August, the May total, 13·96 inches,

being the highest ever recorded for any month. By contrast, a new low record was set up in June, and in mid-September a drought began which continued unbroken until mid-February. A disconcerting feature of this sequence was the rapidity with which the general agricultural conditions of the country deteriorated from a state of luxury to one bordering on famine. Subsequent recovery was rapid, but the history of this drought received careful consideration in relation to all aspects of plant breeding and agronomy which might have a bearing on any future recurrence of the event. Serere, which plants cotton early, achieved a normal crop.

The Uganda crop as a whole, aggravated by previous low prices and disturbed marketing conditions, was the lowest for 20 years.

Agriculture.

Manurial Trial.—This experiment entered its fourth cropping cycle (tenth year) with a fresh application of manures followed immediately by a crop of cotton. The effect of the manures on the development of the cotton plant was most marked and once again there was a close positive correlation between *Lygus* damage and plant height. Yield gave a most interesting result in that it was highest with 10 tons of farmyard manure to the acre, the quadratic component of the series 0, 10, 20, 30 tons being negative and significant. Thus it seems that land that is now too poor to sustain a crop of *Eleusine* can still be over-manured for cotton. The percentage of stained cotton rose sharply with increasing doses of manure ; there was a serious infestation of *Dysdercus superstitiosus*, F. beginning in the fourth month of growth, and the fact that the insect tended to congregate on the larger plants was probably responsible for this. Manuring decreased ginning percentage, as is usual, but it also decreased seed weight, which is most inexplicable unless *Oxycarenus sp.*, also prevalent, was responsible.

Cotton Seed and Meal Manurial Trial.—This was resting under grass.

Cotton Seed and Ash Manurial Trial.—Manures were applied a third time followed by a third crop of cotton. Plant height and *Lygus* damage were both increased by manuring, particularly seed. Jassids, on the other hand, were less prevalent on plots manured with seed. *Dysdercus spp.* again bred on the seed when it was concentrated along the lines of plants, so that this mode of application must be considered unsuitable. In fact this experiment was one of the principal breeding grounds for *Dysdercus* referred to later in this report. This year, a dry year, yield was greatly increased by manuring. It was doubled by seed and raised over 40% by ash. At the first level (one ton of seed or ash equivalent per acre) ash was more effective than seed, indicating a primary mineral requirement rather than an organic one. Manuring lowered ginning percentage and raised seed weight as is usual.

Fertility Experiment.—Cycle II was cleared early in the dry season and cultivated thoroughly to free it from *Imperata cylindrica*, Beauv. In the previous cycle it had been found that the first cotton crop tended to reflect the manner of opening up rather than treatment during the resting period. This time the cotton sustained heavy *Lygus* damage and grew very rank and tall, suggesting soil of high nitrogen status, such as one associates with bare fallowing in English farming. The yield was the highest ever achieved on this experiment. In spite of the careful preparation of the land, however, plant height and *Lygus* damage were still greatest after the shortest of the three resting periods, and after Mucuna as opposed to grass, both these treatments being aspects of the vegetable cover before opening up. Seed weight was the only character which reflected the manures applied four years before. Yield was markedly less after Mucuna dug in as a green manure. The chief interest of this cycle was that it enabled the Senior Chemist to build up an excellent series of records on soil crumb structure, crumbs having regenerated steadily with the longer resting periods, but not during the continual disturbance of Mucuna dug in as a green manure.

On cycle I cotton followed *Eleusine*, the latter having given a response of 27% to the longest of the resting periods. This cotton gave a true reflection of the resting period. *Lygus* attack was severe, even though the cotton was sown comparatively late, and it persisted longer than is usual at Serere. Unlike cycle II, plant height increased with the resting period and was least after Mucuna dug in as green manure. Farmyard manure was applied after the *Eleusine* and plant height responded to this, though the response was curved, with an optimum at the lower dressing (2½ tons per acre). *Lygus* damage was greater on the manured plots, being the greatest of all after the longer resting period combined with the heavier dressing of manure. Cotton yield also gave a response of 20% to the longer of the resting periods, and it gave a curved response to manures similar to that of plant height.

Interplanting Experiments.—An experiment with tepary beans and cowpeas in cotton was carried out at both Serere and Ngetta. Interplanting at the time of sowing cotton was successful, but owing to the abnormally dry back-end, the September and November interplantings in standing cotton failed altogether. At neither place would cotton tolerate cowpeas and the yield was considerably reduced. At Serere it was observed that there was much *Lygus* damage on cotton interplanted with cowpeas. But cotton and tepary beans were relatively successful, particularly in May plantings at Ngetta. An experiment at Serere with pigeon peas and cassava in cotton was similarly restricted by the dry weather. Interplanting at the time of sowing cotton brought about, as was fully expected, a 50% loss of yield with pigeon peas and a 33% loss with cassava. The real point of this latter experiment was to test the effect of interplanting these crops late in standing cotton, and the season did not allow of this.

Planting Methods Experiment.—This year continuous sowing with mud-treated seed took rather longer than the ordinary method and used much more seed. This was due to the ground being rather hard and the seed badly ginned. There was no difference in the final yields. On balance the method to be preferred is probably a matter of choice depending on local conditions.

Gap-filling Experiment.—The Serere experiment was started in June and after two attempts was abandoned because the stands realised were not good enough for the purposes of the trial. At Ngetta the experiment was carried through successfully and gave no differences in yield; this confirms, possibly without the need for further experiments, that gap-filling under a fairly wide range of conditions does not pay. In other words it is all important to establish a good stand at the first attempt; and, provided this is done within the range of spacing recommended as the result of past work, a few gaps can be regarded with complacency.

NPK Experiment.—A miniature experiment was started with 4-plant plots. Dressings corresponding to 2 cwt. sulphate of ammonia, 3 cwt. superphosphate, and 2 cwt. sulphate of potash were applied three weeks after sowing. The response to nitrogen was immediate and large; height was increased by 20% over control in a short time. Height also responded to phosphate in the presence of nitrogen. The nitrogen plots set 74% more bolls and yield was increased by 86%. Unfortunately the experiment was too small and isolated to demonstrate any effect on the incidence of Blackarm, *Lygus* or jassid, which was one of its main purposes. The experiment is being repeated on a field scale.

Genetics and Breeding.

It has now been proved beyond doubt that fuzzy seeds produce a crop with a higher ginning percentage than one raised from "black" seeds separated from the same bulk. Taking the fuzzy character as recessive to one or more "black" characters in *G. hirsutum* (all of which is in accordance with the findings of geneticists in other countries), the task of eliminating "black" seeds and the low ginning percentage associated with them has proved relatively simple, and is now virtually complete in all small plots. The elimination of "black" seed from the whole commercial crop is therefore only a matter of time if due care is exercised. No apprehension is felt on the score of lint quality since our two best staple cottons, BP.52 and SG.29, are both fuzzy seeded, the latter in very marked degree.

The wide range of material collected up at Serere in the last three years was sprayed with Blackarm suspension according to the technique of Knight and Clouston in the Sudan, and some three thousand resistant phenotypes were selfed and harvested individually. The progeny have been planted out and sprayed again in order to isolate homozygous resistant lines. There seems little doubt that we have successfully tracked Knight and Clouston's $\mathbf{B}_2$ character for resistance in *G. hirsutum* types. Serere is fortunate in that none of its principal strains is

homozygous susceptible like BP.52 at Kawanda. All work on other characters was held in abeyance pending the completion of the Blackarm examination.

Since it will take a long time to confer Blackarm resistance on BP.52 by backcrossing at Kawanda, a quicker interim procedure was started at Serere. BP.52 and N.17, both of them derived from the same Nyasaland Upland stock, are very much alike in plant type ; in fact they were almost indistinguishable to the eye in a current trial. BP.52 was therefore hybridized with pollen from Blackarm-resistant phenotypes of N.17. The F_1 hybrid generation was grown out of season in an insect-proof cage, and after spraying with Blackarm suspension a few susceptible plants were eliminated. The remaining plants were selfed. It is intended to take resistant phenotypes in the coming generation and sort for homozygosity in the generation following. In this way it may be possible to obtain a serviceable resistant hybrid for immediate purposes.

The hybrid between BP.50 and the strain with red plant body was backcrossed to BP.50. The object of this side line is to transfer the red character, which is useful for demarcating plots and other purposes, to a strain which is not obnoxious for other reasons.

The Variety Trial programme was maintained in full pending the emergence of new strains resistant to Blackarm. Four trials contained a total of 81 varieties. The lattice square design with 25 varieties in 150 plots was again very successful, and in one trial at least mitigated local differences caused by *Digitaria scalarum*, Chiov. This weed is very troublesome in Buganda and its appearance in epidemic proportions on one of the experimental fields at Serere is a very great catastrophe.

SP.89 and BP.50 suffered consistently less *Lygus* damage than other varieties, though the difference was not large. The same strains were also the most resistant to jassid attack. B.181 and its derivatives were in a class by themselves for resistance to Blackarm. BP.52 was the highest yielder amongst the better known varieties, a result which, taken in conjunction with the findings of the previous season, must cause quite a revolution in Serere ideas. Other high yielders were B.181 and its derivatives, S.1307, and the supposedly degenerate Nyasaland Upland bulk which is grown in Busoga and Bukedi. It was not such a good year for BP.50. S.1307 and its derivatives gave the highest ginning percentages. B.181 with its rather higher ginning percentage, and in particular its derivative S.1310, tended to capture the lead for yield of clean lint. The best lint length was found in BP.50, BP.52, S.2114 (from N.17), S.1310 and three grand-daughter strains of B.181. A further interesting point was that B.181 had much the smallest infestation of *Argyroploce leucotreta*, Meyr. One trial was devoted largely to the second series of Serere hybrids and the series of hybrids received from Nyasaland. Although useful characters were present individually, useful combinations of characters were entirely lacking.

In the district trials B.181 was quite alone in its resistance to Blackarm. In the north-west there were no significant differences in yield of clean lint, although B.181 was a little down in yield of seed cotton. In Lango and Teso there were no differences in yield of seed cotton, but B.181 and BP.50 drew a little ahead in yield of clean lint. BP.52 was the highest yielder in both Bukedi and Busoga (it was not tested in Lango and Teso, but it scored the highest total of clean lint in the north-west also). Unfortunately the behaviour of S.2102 (from N.17.M2) was spoilt by the use of inferior seed. B.181 was fully the equal of SP.84 in Usuku, the only remaining area where SP.84 is still grown.

The type collection was considerably augmented with material received from Trinidad.

Multiplication.

Two consecutive seasons of low yield left very little progress to record, and in any case an account is hardly worth while owing to wholesale redistribution of seed in 1943 after the collapse of the commercial crop in 1942–43.

Spinning Tests.

The Shirley Institute's 10-lb. tests showed that BP.52, BP.50 and B.181 were the best spinning cottons in the series of district trials organized from Serere. The two latter varieties seem to produce relatively much better cottons in the Serere area than they did at Bukalasa where they were bred. The 1-lb tests also favoured S.1103 (from N.17.M3), other members of the BP.50 family, and SP.84. The first series of Serere hybrids, selected for ginning percentage and lint length combined, were not successful, and later observations have made it plain that such selections are based more on ginning percentage than on lint length. A commercial consignment of B.181, by courtesy of Messrs. Ralli Bros., was classed as intermediate between BP.52 and A.R. Kampala. Miniature samples of the commercial crop from various localities sent to the Shirley Institute showed A.R. West Nile considerably ahead of any other cotton in the Protectorate. The variety grown there is SG.29. The Indian Central Cotton Committee examined a number of samples, but the range of highest standard counts was so small that it was impossible to draw conclusions.

Entomology.

Attack by *Lygus simonyi*, Reut. was rather late, was well up to ordinary severity, and persisted much longer than usual. Jassid attack was on a very small scale. A good deal of stainer damage was sustained. *Dysdercus superstitiosus*, F., which is normally manifest in August and September, bred up on a greatly enhanced scale, and later arrivals of *D. nigrofasciatus* Stal were also above normal. *Oxycarenus* played its part in damaging seed. The trouble was attributed to neglected sanitation, with special reference to the Cotton Seed and Ash Experiment and to the feeding of cotton seed to cattle in the open. Bollworm damage was very small.

Mycology.

Blackarm, the only serious disease of cotton at Serere at present, has already been dealt with under the heading of genetics.

Summary and Conclusions.

The rainfall distribution was most abnormal. Increased attention was given to the agricultural and physiological aspects of cotton-growing, and an NPK experiment was started. Recent knowledge from the Sudan on the genetics of Blackarm resistance was applied to all Serere material. Routine variety trials and spinning tests added still more in favour of the strains brought to Serere from Bukalasa.

PROGRAMME FOR THE SEASON 1943-44.

Unchanged, except that experiments on interplanting and gap-filling may be in abeyance for one year (because the land is infested with *Digitaria scalarum*).

TANGANYIKA TERRITORY.

PROGRESS REPORTS ON COTTON WORK 1942-43.

PREFATORY NOTE

BY

R. W. R. MILLER,

Director of Agriculture.

The year 1943 and the rainy season immediately preceding will be remembered for a phenomenal drought and severe food shortage. These conditions made life very difficult for the native population and were particularly unfortunate in that they occurred at the time that the people were being called upon to produce food supplies for military needs and for feeding labour employed on the production of rubber, sisal and pyrethrum urgently in demand for war purposes. Normal cotton production was aimed at, except in marginal areas where it was considered the farmer would best assist the war by growing a high-yielding food crop rather than a low-yielding cotton crop, and this policy reduced the cotton acreage. In the cotton areas proper the drought in the early part of the season delayed planting and reduced the yield and the crop is not expected greatly to exceed 33,000 bales.

It is gratifying to note the steady progress made at the Ukiriguru and Lubaga Stations and the useful start with investigations at the new station at Kilosa and the related Morogoro district trials. It will be observed that in dry conditions in the Lake Province cotton is less affected than are other crops, that cotton grown in rotation with cereals gives a valuable return without taking as much out of the soil as continued cultivation of grains, and that on the experimental side there are indications that it may be possible to select a jassid-resistant cotton without reducing the lint length. The Kilosa station is dealing with an area in which lint length is fairly satisfactory but in which insect pests are the limiting factor as regards yield, and the work has been so designed in consultation with Mr. F. R. Parnell (who paid us a second very welcome visit) as to throw light on the question whether selection and breeding work or some other line of approach will be the best way of improving our Central Line crop.

UKIRIGURU EXPERIMENT STATION.

PROGRESS REPORT FOR THE SEASON 1942-43

BY

J. E. PEAT.

Introduction.

It has been a difficult year, but in spite of everything, good progress has been made. The Ukiriguru rainfall for 1943, to date, is the lowest of all the stations recorded in the Government *Gazette*. Most of the

cotton-growing portion of the Province fared better than the Ukiriguru area, though, in the South, planting rains were late. The total Lake Province cotton crop was 24,000 bales (Shinyanga 3,800 bales) ; a fair result, considering the drought, the late planting rains in the South, and the general uncertainty this season about the place of cotton in the planting scheme. The value of cotton in the economy of the Lake Province is again apparent—a hardy cash crop in a naturally somewhat poor and dry agricultural area. Rice was a poor crop—a complete failure immediately around Ukiriguru—and groundnuts were mainly a failure.

Cotton should achieve greater stability agriculturally in this economy, (*a*) when any improvement of the fertility of the soils in the more exhausted areas can be effected, and if the fertility is maintained in the newer areas ; (*b*) when a good jassid-resistant strain of cotton can be provided to eliminate the heavy damage by jassid in wet years.

There is food shortage in the Province. The food-crop yields at Ukiriguru show how despite the difficult season moderate to good crops have been obtained by reasonably good agriculture ; they point their lesson. It is easy to get reasonable yields in favourable years on good soils, but more difficult in difficult years on the poorer soil types of the Province. Full advantage must be taken of favourable weather. The native cultivator is very often late, and suffers accordingly.

Though the major part of this report is concerned with cotton, it is well to point out that this past season at Ukiriguru roughly 150 acres were under plots and multiplications of various food crops ; 80 acres under green manure or resting crops ; and 60 acres under cotton, including breeding material, multiplications, and experiments.

The development of Ukiriguru proceeds despite setbacks. There has been water shortage. A tank dam with a capacity of 700,000 gallons, is nearing completion. Water boring has been successful. A house (European) has been built. More of the new area is being prepared for Station work : a considerable amount of road-making has been done. The season ruled out successful tree planting : this will have to be undertaken seriously this coming year. The District Plots, though still imperfect, are now a very important extension of Ukiriguru.

Meteorology.

The rainfall for the season, November 1st to June 30th, was 19·54 inches. The early planting rains were quite good—7·24 inches for November and December, but the rainfall for the first six months of 1943 was only 12·30 inches, mainly in showers. There was no fall of as much as one inch in 24 hours (in fact there was only one fall exceeding one inch in the whole season.) In the South of the Province, planting rains were very late. As a result, the cotton acreage there was much reduced.

Agriculture.

Soil Fertility—Manuring, Rotation and Resting Crops.—Dr. Martin of Uganda paid a short visit to Ukiriguru and Lubaga in June. The opportunity of discussing the fertility problems of this region and the chances of success with a grass rotation on the different soil types was greatly appreciated. He made chemical and structure tests on a range of soil samples.

The problems of fertility—its restoration in the more exhausted, over-crowded areas, and its preservation in the more newly-settled, still fertile areas—are the fundamental agricultural problems of the region. Though imperfectly and somewhat crudely at present, what is possible is being attempted to help clarify the position in the area served. In difficult years there are food shortages. In part, the effects may be mitigated by more knowledgeable agriculture, and in part, in the more exhausted areas, by improved soil fertility. (Quite apart from the direct effects of soil fertility on the growing cotton crop, there can be no cash crop stability, and therefore no stable economy, insofar as cash crops affect it, when food is short. Food must come first.)

The manuring and rotational responses recorded this year are much as reported in other years. Cotton showed up to a 40% increase from the heaviest application, 7 tons per acre, of farmyard manure : a yield of 960 lb. per acre seed cotton compared to 690 lb. per acre. The cotton was established before the main drought period. The bulrush millet portion of the trial was not significant : patchy plot stands upset results. There was only 100 lb. per acre difference between the heaviest application and the control. The millet was planted in December.

The second-year responses this year are significant in three out of the four comparisons ; around 20% improvement in grain yield, from the heaviest application in the 1941–42 season, 5 tons per acre farmyard manure.

The improvement to the grain crop as a result of following cotton in the rotation, has again shown up, though this year the yields cannot be compared statistically. Dressings of compost have produced much the same increases as the same quantity of farmyard manure. The Katumbili maize yields in the one trial on the hill (Appendix 1) are interesting compared with the millet yields from the similar trial.

Results are inconclusive from the observation plots of pigeon pea and elephant grass dug in at the end of the 1942 rains ; the drought has added complications. Millet and cotton suffered where the whole of the crop of elephant grass had been dug in, though when the ridges were turned in November, it seemed to be breaking up well, and by June not much residue remained. The results following the digging-in of the resting crop trials at the end of this 1944 season will have to be awaited.

A further resting crop trial was laid down, planted through millet, but it fared badly in the drought. It will be refilled. There was difficulty in establishing elephant grass at Ukiriguru and in the district plots, and much that was established had a hard time through the dry season. Pigeon pea was established more easily, but on some patches of soil has suffered through the dry season. Two seasons seem to be as long as it should stay down. Termites damage the plants and reduce the stand. On the deep exhausted Lake shore sand in the Nassa district, the Pigeon pea resting crop has done especially well, and in this the second season has yielded heavily and very profitably to the grower.

It remains to be seen what effect a grass rotation will have on the structure of the exhausted sandy hill soils—where the need for fertility restoration is greatest. Martin has commented on the lack of colloid in these soils; he considers that the chances of success are much greater on some of the other heavier soils, " itogoro " ; " ibushi " ; " nduha."[1] On these the response will have to be noted in the district plots. On the lighter hill soils maximum manuring may have to be the main approach—a mere feeding of the crop. Methods of adding body to the hill soils will be tried.

The striking increase in paddy yield from the digging-in in heavy " mbuga "[2] of a considerable quantity of green material, one month before planting out the rice seedlings, has probably little relationship to soil fertility, and green manuring as such, but rather to the decomposition of the green material and the effects of this on flood-land aeration.

Food Crops.—A range of food crops is grown each year, partly multiplications for seed issue, and partly to observe behaviour. Millet yields were on the low side, much around 500–700 lb. per acre. Katumbili maize in a second-year manurial trial on the hill, planted mid-December, yielded 1,150–1,500 lb. per acre. Kenya Hybrid maize in the " mbuga " planted at the same time, unmanured, yielded 2,200 lb. per acre.

The early-maturing sorghums, Nzanza and Dobbs, yielded poorly, about 350 lb. per acre; the middle-maturing group yielded better, around 700–800 lb. per acre; and the high quality late-maturing Wiru types yielded well, around 950 lb. per acre. These were all planted dry at the end of October in " mbuga " and unmanured. There was a marked falling-off in yield where planting was delayed. Katumbili maize, for example, planted in " mbuga " in the third week in January, yielded only about 100 lb. per acre. Groundnuts yields were low and the quality was poor.

Early-maturing types of food crops are of especial importance following a year such as this : planted with the first rains they provide

[1] " Itogoro " : the seepage area soil type—clay loam to sandy clay.
" Ibushi " : a black loam, as at Lubaga.
" Nduha " : a bright red clay loam.

[2] " Mbuga " : valley-bottom, heavy black fissuring clay.

some food 2½–3½ months after planting, long before the main harvest—a period of food scarcity in most years. The difficulties are seed arrangements—adequate multiplication and storage—the seed of most types stores badly. The dwarf sorghums P.41, P.127, P.133 from Swaziland aroused much interest, and may have a value in providing early food. They are rather low yielders, but considerably earlier under these conditions than any of the other sorghums grown.

A cowpea—Chora—maturing in 2½ months, did well this year, yielding around 400 lb. per acre. Also a high quality sweet potato, Caroline Lea, is early-maturing, and may have a special value in providing early food.

The loss caused by *Striga helmonthica* is very serious in some areas. Clean weeding greatly reduces the loss as the Ukiriguru yields showed. Observation plots of Bukura mahemba sorghum planted in " mbuga " heavily infected with *Striga helmonthica* gave miserable yields, a mean of just over 100 lb. per acre. A manured plot alongside (12 tons per acre) gave 1,000 lb. per acre without any weeding of *Striga*. Bulrush millet in the same plots, with no manure and no weeding of *Striga*, yielded 850 lb. per acre.

Contrary to expectations, an experiment to show the loss caused by delay in harvesting bulrush millet showed no drop in yield with a delay of six weeks. There was no bird damage this year at Ukiriguru.

Rice.—The Provincial rice crop was poor—around Ukiriguru it was a complete failure. Dependant as it is mainly on storm water, rice cannot have the stable position in the agricultural economy that cotton should have (the position would be very different if considerable areas could be irrigated from the Lake) but as the people get accustomed to eating rice themselves, it should play an increasingly important part in their food supply. The run of paddy yields are relatively high compared, for example, with millet yields.

At Mwabagole Rice Station only half the acreage could be planted ; this was irrigated by pumped water from the Lake. The results showed that it should be possible to help considerably in raising the level of local yields. The increased yields reported resulting from the trampling-in of green material a month before transplanting the seedlings may be very important. Kahogo and Melli No. 2 are of good quality. The native paddy is mixed which reduces the value of the milled rice. Seed of pure Afaa Mwanza is multiplied for issue to replace the mixed native seed. The selections in the trial, though slightly later, show big improvements in yield on pure Afaa Mwanza used as the Control. 1942 selections have yet to be tested. Some show considerable promise. There would seem to be big opportunities for strain improvement.

Land at Mwabagole prepared for rice, which could not be planted owing to the drought, was planted in April to Chick pea (*Cicer arietinum*). The yield was excellent, around 1,700 lb. per acre. The price is high.

Cotton Spacing Trials.—The Ukiriguru cotton-spacing trial was not significant. The mean yield differences were small, the top yield, at 2 rows per ridge × 12 inches between hills × 2 plants per hill, was 860 lb. per acre ; the bottom yield, 2 rows per ridge × 24 inches between hills × 2 plants per hill, was 800 lb. per acre.

Considering the district plot trials as a whole, the safest spacing was 2 rows per ridge × 12 inches between hills × 2 plants per hill. A third row per ridge gave more stunted plants, though under the poorer conditions the yield was slightly higher. Increasing the spacing to 24 inches, two rows per ridge, caused a drop in yield, less in the Lake shore plots than under the poorer conditions. One row per ridge instead of two, except in two of the Lake shore plots, gave a further drop in yield.

All crops in the district plots were on the ridge, base 5 feet. In the Lalago plot, on soil similar to that at Lubaga, the improved growth this year from ridge planting compared with planting on the flat was a matter of local comment.

Cotton Breeding.

The cotton selection work continues to be one of the most important activities of the Station. As a result of the evidence now available (which would have been very incomplete without the strain trial result from the district plots) it is apparent there will not be the quick step up in production that was hoped for at one time, merely by the issue of an improved strain.

Without jassid damage, " Local " is better in the field than was at first thought from field observation alone. There is vigour, and the crop is normally made over a period of months. There will be improvement, but not as simply as was at first thought possible. The big step forward will be the issue of a strain having good jassid resistance, thus eliminating the severe jassid damage experienced in a wet year.

The aims in the breeding work are as previously stated :—good jassid-resistance, crop yield, plant vigour, and lint quality, combined with a reasonable ginning outturn. Selected lots this season have shown that there is not the incompatability at one time thought possible between jassid-resistance and good lint quality, particularly lint fineness. Selections from Uganda BP.50 lots, and to a lesser extent from " Local " lots, show varying degrees of good jassid-resistance allied to good quality, fine, silky lint.

There were three strain trials at Ukiriguru, and twelve in the district plots (the thirteenth was wiped out by insect damage). These district trials are essential for any reliable estimate of strain behaviour for the year. " Local " and Mz.561 (Ukiriguru seed) gave much the same yields. Mz.561/6 is not enough of an improvement to be worth continuing ; apart from its other qualities its ginning outturn is around 1% below that of " Local " and Mz.561. It can be said that

this year probably no benefit has been gained by the growing of Mz.561 in place of " Local." In two of the trials at Ukiriguru there was nothing between them; in the trial in the "mbuga," with some jassid damage, Mz.561 was appreciably the better yielder—in one portion of the trial significantly so. In the district plots the tendency was slightly in favour of " Local " in the better Lake shore areas, and in favour of Mz.561 (and more so in favour of Mz.561/6) in the Kwimba and Maswa plots where planting rains were late and where there was jassid damage. Mz.561 has moderate jassid-resistance ; this will give it an advantage in a wet year, but a considerably higher degree of resistance than the bulk possesses is required.

G.9/278 (ex Uganda BP.50) has yielded disappointingly throughout, appreciably lower than " Local " or Mz.561. It has a combination of good jassid-resistance and good quality lint. A large number of single-plant lots from it were grown, but nothing of much promise has shown up. BP.50S6 (a Uganda selection) in one Ukiriguru trial yielded significantly better than the sister strain, G.9/278. Selections will be taken from BP.50 itself, seed of which it is hoped to get from Uganda. Other varieties tried included MU8A, a Malwa Upland of super jassid-resistance but low lint quality, and 0/16, a selection from Mz.561 good for jassid-resistance. The Uganda strains BP.52 and B.181 again looked as though they were not happy growing at Ukiriguru, which is scarcely surprising considering the rainfall for the season.

The main selection work goes on within material of " Local " origin. 1/35 and 1/45 have defects ; it is hoped to improve on them by further selection. Newer lots are promising, but they have still to be tested. In requiring good jassid-resistance, yield, vigour, good quality lint and at least a reasonable ginning percentage, a fairly high standard is being set and there has to be considerable discarding of material failing in one or more particulars. Allowing for a falling-off when a strain reaches general cultivation, a higher standard of lint quality is aimed at than shown by " Local " or Mz.561. The results from the 1942 lint sent for brokers' reports and spinning tests had not arrived at the time when this Report was written (November).

Seed cotton was harvested separately from plants in " Local " showing " Naked " seeds and " Fuzzy " seeds. The varying degrees of nakedness are included in " Naked," and the varying degrees of fuzziness in " Fuzzy." " Naked " ginned out significantly higher, a mean of 31·21% compared with 30·37%, because of a lower seed weight, a mean of 9·52 gms. compared with 10·31 gms. per 100 seeds : the lint index figures were in favour of " Fuzzy," a mean of 4·51 gms. lint from 100 seeds compared with 4·37 gms. The differences are significant. These results are of interest, and are not in agreement with the Uganda results.

Entomology.

Jassid.—Jassid was not an important pest this year. At Ukiriguru damage was noticeable only in the " mbuga " cotton. In the district

plots quite appreciable loss was caused in three of the Kwimba plots. Serious damage seems to be linked with wet years.

American bollworm.—The precautions against American bollworm attack on cotton, mentioned in last year's report, were taken—ratooning of the pigeon pea, and no maize planting before mid-December. Whether because of this or not, there was no American bollworm attack, nor was bollworm a factor in any of the district plots as far as is known, except Msalala.

Stainers and Callidea.—These are grouped under the one heading. It is difficult at present to differentiate between the amount of damage each causes. In some areas *Callidea* is the most serious ; in others, particularly towards the South of the Province, stainers probably do the most damage. At Ukiriguru there seemed to be comparatively little loss. The staining loss is indicated to some extent by the percentages of C grade cotton to the total crop picked. There was heavier loss in the districts of Kwimba and Maswa. But taken all over it was not a bad " staining " year.

Callidea was seen in the Ukiriguru cotton off and on from February, at times in fair numbers. The stainers first found in the cotton in April were the herbaceous ones, *D. superstitiosus* and *D. nigrofasciatus*. Towards the end of the season *D. fasciatus* came in in small numbers. In Kwimba and Maswa districts *D. fasciatus* was probably more important, and at the Lalago plot *D. cardinalis*.

Capsid—Lygus ?—At Ukiriguru *Lygus* was noticeable only in the " mbuga." The loss caused cannot have been much. The high cotton yields obtained there this year (" Local " 1,600 lb. per acre) are in marked contrast to those of last season which was wet and with crippling *Lygus* damage—when " Local " yielded 200 lb. per acre (page 111, 1941–42 Progress Reports).

On Ukerewe Island considerable bud loss caused by *Lygus* without very marked leaf damage was noted in May. This was in the fertile portion of the island, where cultivation from forest is recent and where plant growth is sappy. In the Uzinza area there was considerable loss of top crop due to *Lygus*, in " miombo " (*Brachystegia*) country away from the Lake shore ; the Lake shore cotton was entirely free from damage. On some shambas newly-broken from bush, *Lygus* damage on late-planted sappy cotton was crippling. In the middle and South of the Province no damage was seen.

Aphis.—At Ukiriguru aphis was again very bad on the hill cotton in January, February and early March. Serious stunting of the growing plants was caused. It disappeared at the end of March and in April. The " mbuga " cotton suffered little. This stunting of the plants by aphis every year must cause considerable loss of crop ; plants are slow in growing away after the damage. It may have an effect on strain trial comparisons where strains have different fruiting habits. The damage may be the greater on Ukiriguru, where, because

of shortage of suitable land, cotton experiments have been planted for several years running on the same land, and where the area of cotton in one block is larger than is usual among the cultivators. This difficulty may disappear as more of the new area comes into use.

Summary and Conclusions.

The work being undertaken at Ukiriguru, Mwabagole, and the district plots, is of considerable importance to the agricultural development of the area served. There are still many imperfections ; at present with the shortage of everything and the general crudeness, much is in the nature of a compromise.

Early planting rains were quite good, but the rest of the year was very dry. The value of cotton in such a year has again shown up. There is food shortage in the Province. The yields of the Ukiriguru food crops, despite the drought, point their lesson. Mention is made of early-maturing food crops, which may have a food-shortage value.

Manuring, cotton rotational, and resting crop experimental results are given.

The district plots have given information of much value. The spacing results support the recommended spacing of 2 rows per ridge × 12 inches between hills × 2 plants per hill. It cannot be said that this year Mz.561 shows any improvement in yield over " Local." The Gatooma selection from Uganda BP.50 is appreciably a poorer yielder than " Local " or Mz.561, but the BP.50 family is worth attention. Strains are being grown which show no incompatability between jassid-resistance and lint quality.

The selection work and the testing of the material proceeds—a fairly high standard is set.

The rice experimental results show that it should be possible to help considerably in raising the level of local rice yields.

PROGRAMME OF WORK 1943-44.

Development, Food Crops, and General Activities.—The development work on Ukiriguru, the seed multiplication, varietal observation, and general farm activities, will continue as fully as present facilities allow. In the district plots a range of the early-maturing food crops will be tested. A trial will be attempted to get some measure of the extent of the loss caused by *Striga helmonthica* ; and there will be a trial to measure the possible value of the Ukiriguru Katumbili maize seed multiplied for issue as an improvement on native seed.

Soil Fertility, Manuring and Rotation.—Further manurial and cotton rotation and resting crop trials will be undertaken. The manurial and rotation work at present in hand will be followed up. The two resting crop trials established in 1941–42 will be broken up at the end of the 1944 season.

Cotton.—The cotton work will continue along the lines discussed in the report :—selection and the testing of possible material at Ukiriguru and in the district plots, and also spacing trials.

Rice.—The present range of strains will be kept going with larger multiplication of the best varieties and strains. These will be tested in variety and strain trials with complementary observation plots in the seepage area on " itogoro "—under conditions very different from those at Mwabagole. A trial will measure the responses from digging in green material before the transplanting of the seedlings (various possible materials and varying rates of application). There will be complementary observation plots at Mwabagole and on " itogoro."

APPENDIX 1.

Ukirigugu. Experimental Details—Manurial and Rotational Responses.

1 ton = 2,000 lb.

1942–43 Manurial Trial—First Year Responses.

Cotton Mz.561. Soil : Hill Sand.

Treatment.	*Mean yields, lb. seed cotton per acre—1943.*
Farm yard manure, 7 tons per acre	960
Compost, 3 tons per acre	900
Stalks 2 tons, farm yard manure 1 ton, per acre	870
Farm yard manure, 3 tons per acre	850
Pen-trampled wastes, 3 tons per acre	820
Control	690
Least significant differences	P=·01 146 ; P=·05 113

1941–42 Manurial Trial—Second Year, and Cotton Rotational Responses.

Katumbili Maize. Soil : Hill Sand.

1941–42 Treatment.	*Mean yields lb. per acre—1943.*	
	Following	
	Cotton.	*Bulrush Millet.*
Farmyard manure, 5 tons per acre	1,560	1,520
Pen-trampled wastes, 3 tons per acre	1,550	1,190
Farm yard manure, 3 tons per acre	1,530	1,260
Compost, 3 tons per acre	1,500	1,190
Control	1,440	1,140
Least significant difference	Not significant	P=·05 167

1941–42 Manurial Trial—Second Year and Cotton Rotational Responses.

Bulrush Millet. Soil : Hill Sand.

1941-42 Treatment.	*Mean yields per acre—1943.*	
	Following	
	Cotton.	*Bulrush Millet.*
Farm yard manure, 5 tons per acre	620	570
Farm yard manure, 3 tons per acre	600	530
Compost, 3 tons per acre	590	530
Pen-trampled wastes, 3 tons per acre	570	490
Stalks, 3 tons per acre	520	470
Control	520	470
Least significant differences P=·05	76	57

LUBAGA EXPERIMENT STATION, SHINYANGA.

PROGRESS REPORT FOR THE SEASON 1942-43

BY
A. N. PRENTICE.

Introduction.

Rains were very light. A poor rainfall on the played-out lighter soils of Shinyanga inevitably leads to poor crops, and the food supply in many areas will be on the short side for another year. The areas with heavier soils fared rather better, and the low-lying stretches of " mbuga " soil had some good crops, especially of cotton.

The Lubaga crops were planted in good time and made the best of the conditions. Growth of the cotton was small, but the plants were efficient for their size and the general level of yield was satisfactory.

Weather.

Lubaga rainfall for the season was 23·03 inches, the lowest on record. The usual rainy season, November–May, had 21·90 inches, but showers in October and an unusual but very welcome extension of the rains into early June made up the difference. The district had a similar rainfall. Distribution in the mid-season months was bad.

Agriculture.

Soils and Manuring.—The work of the district trials was shared this year with the district Agricultural Officer, Mr. C. J. M. Krige, until he was transferred in May. The plots were on the whole a fair sample of the reaction of the various soil-types to the season. The low-lying heavy " mbuga " soils were good ; the sandy soils, including the red loams were poor ; and the black loams of the same type as Lubaga again did well on the whole, these soils being undoubtedly not only the best in the district for cotton, but the steadiest from season to season. A soil-type known as " ibambasi hard-pan " was included in district plots this season ; yields were better than expected, one of the two " ibambasi " plots giving the highest yield of all the district plots. These hard-pans in their various sub-types occupy large stretches in Shinyanga. The natives use some of them for sorghum and, occasionally, cotton ; but they are intractable soils which need careful handling, and are obviously destined for experiment.

Some generalizations on the fertility of the black loam soils—in brief that these soils do not " exhaust " quickly, and are not particularly responsive to manuring—are discussed in Appendix 1.

Cultural Practices.—Cultivation methods made a great difference to yields this year. Cotton was less sensitive than maize, but even with cotton the increase due to ridging contrasted with flat cultivation was important. Experience with ridging on black loam soils is discussed in Appendix 2.

Of cotton spacing and time-of-planting experiments on Lubaga and in the district there is little new to say. On Lubaga, in a trial on a fairly high plane of yield, the optimum plant-density was passed in a treatment giving approximately 116,000 plants to the acre, the yield falling 16% (significant at P.=·05) below that of the best treatment of 58,000 plant-density ; the latter is still a very dense stand, of course.

A time-of-thinning trial on cotton on Lubaga, expected to give clear-cut results in favour of early thinning, was inconclusive.

Rotation, etc.—The district was switched completely from U.4/998 cotton to Mz.561, and growers were told to plant the new variety on land that was not under cotton the previous year, to avoid mixing.* Willy-nilly there was some rotation in the district this year. though it was far from being complete. In the opinion of the agricultural instructors grain crops following cotton were better than those which, on the same type of land, followed the usual continuous grain.

A rather unsatisfactory trial of "previous treatments" on Lubaga indicated that sorghum on this black loam soil may show no great response to preceding cotton, but may derive benefit from even as little as one year of elephant grass ; its yield seems to be depressed by a preceding crop of Kavirondo perennial hybrid sorghum.

A fair acreage on Lubaga is now under elephant grass, but the best methods of handling the crop under local conditions, and its effect on the soil, are just coming under experiment. Some of next year's cotton break will follow two-year elephant grass. Of the other grasses under observation, the wild *Cenchrus ciliaris* maintains its promise, and about an acre of it was seeded fairly successfully. A number of other wild grasses and legumes was brought under observation, but none was established well from seed. The large pigeon-pea break on Lubaga was ratooned as an anti-bollworm measure—and whether due to this or chance, American bollworm attack was negligible this season—but the ratooning, probably in conjunction with the hard season, reduced the stand very badly.

Three new Swaziland sorghums received from Ukiriguru were remarkable for their quick maturation-period of three months and caught the natives' attention at once.

Cotton Breeding.

Mz.561 replaced U.4/998 all over Shinyanga this season, and behaved well considering the conditions. The seed was bulk that had been in general cultivation for a few years in the northern end of the

* Chopping of old cotton stalks is compulsory, and thorough on the whole, but plants from adventitious buds underground, and self-sown seedlings, often make an appearance in old fields, and contaminate the succeeding cotton crop. Incidentally, such chance plants are early by their very nature, and often provide a ready-made demonstration of the value of early planting.

Province, and, compared with the Lubaga stock, it has altered slightly, although still obviously Mz.561.*

The selection and testing work made normal progress on Lubaga. The merits of the pre-1940 strains are now fairly well known ; they contain nothing better than Mz.561. Of the 1940 class, in formal trials for the second time, and tested in the district for the first, some maintained and some failed to maintain their last year's promise in the field ; there seems to be nothing in sight amongst them, as they stand, good enough all round to displace 561, though some have better field qualities and others better lint. The district trials, in which the new stock of 561 seed was used for the strain comparisons, confirmed Lubaga results in general. The 1941 class, in trials for the first time, again has some good performers in the field, but the lint has still to be tested. The bias is more and more to lint-quality in the selection work. The 1942 class has some selections in which the lint is obviously good by Lubaga standards, but these have still to come into orthodox yield trials. (A note on the system of progeny-plot arrangement used on Lubaga this year is given in Appendix 3.)

The Nyasaland strain N.C.4 again outyielded Mz.561 (*i.e.*, 561 which was a mixture of the old and new stocks) on lint, though not significantly, and looked well in bulk. Small-scale spinning tests carried out by the Shirley Institute on lint from one of last year's Lubaga trials place N.C.4 above Mz.561 yarn, both on strength and appearance.† If the lint of N.C.4 proves consistently as good as or better than that of Mz.561, N.C.4 must be considered a possible strain for the district, as its good jassid-resistance makes it a safer strain than Mz.561. Mr. Ducker gives the breeding of N.C.4 as Cambodia × U.4 backcrossed by U.4, the U.4 parent being related to U.4/920.

Several new Ukiriguru strains were tried this year and behaved much as at Ukiriguru. The 561 derivative, 016, kept its distinctive features of excellent hair, but shortish lint. The Uganda strain BP.50S6, obtained *via* Ukiriguru, combined lint-length and hair both markedly superior to Mz.561 ; and in a strain trial on Lubaga BP.50S6 came within measurable distance of Mz.561 yield, giving 216 lb. lint per acre, compared with 561's 249 lb. MU8A was not included in trials.

* This very simple case of " deterioration " is worth a note. The last importation of 561 to Lubaga from its Ukiriguru source was made some years ago. The new bulk importation has either changed its type slightly, or more likely has been mixed to some extent with the Mz.Local it was displacing ; at any rate, it has on the average a slightly lower jassid-resistance, slightly greater height, lower ginning percentage, and seemingly a lower yield than its prototype. The usual 561 control in two Lubaga strain trials was split to include 561 of either history, and in one, the new stock was 20% (significant at P. = ·05) and in the other 16% (not yet checked for significance) below the old Lubaga stock on crude yields (stand rather in favour of the old Lubaga stock). The new stock grown at Lubaga from a single sack of seed obtained from the distributing ginnery, may not have been a representative sample of the bulk, of course. Or the old Lubaga stock may be the one that has changed, as it has always been open-pollinated, and the seed has been acid-treated for (the previous) two seasons, which conceivably has had some selective influence on it.

† A very large number of other samples was put through the small-scale spinning test by the courtesy of the Shirley Institute.

Entomology.

Jassid.—Jassid attack was very light this year, both on Lubaga and in the district.

Stainers.—Dysdercus attack was lighter than usual, at least until well on in the season. Adult populations were still below 4,000 per acre at the end of May on Lubaga ; *D. fasciatus* led easily in numbers, *superstitiosus* was next, *cardinalis* was well down this season, and *nigrofasciatus* was, as usual, negligible. The district on the whole seemed to have even fewer stainers than Lubaga, and this freedom from stainer coupled with the unusual late rains undoubtedly saved the district crop, of small acreage and much of it late-planted, from wreck.

Calidea dregii, however, was present as usual. It again defeated any attempt to estimate what seemed to be its true population. As usual, it came into the cotton suddenly, late in March, and left in early May, although stragglers remained for some time and were breeding. Counts, sampled as for stainers, put the peak population in April at but 800 per acre, whereas in patches it was easy to find half-a-dozen *Calidea* per plant. The attack was extraordinarily patchy from point to point and field to field, without apparent reason. *Calidea* undoubtedly accounted for much of the staining on Lubaga, and the attack was also heavy in parts of the district.

The proportion of stained cotton varied widely in the various Lubaga trials, but 30% stained can be taken as typical this year. This figure seems to contradict the statement that stainer was unusually light. However, stainer damage as measured by the number of bolls attacked and not by the degree of staining *was* less than usual. Apart from observation, records show that boll-recovery was high this season, at 45% of the possible from flowers of the " effective " period ; and it is a reasonable assumption that the correspondingly low boll-shedding was partly a reflection of the light stainer attack.

A time-of-planting trial on Lubaga showed much increased staining with later planting, the five successive planting dates from early December to mid-February showing 30%, 37%, 80%, 89% and 100% staining. The district trial plots showed staining ranging from 13% to over 50%. The plots on " ibambasi hard-pan " soil appeared to suffer less than the others from staining. The district results this year to some extent confirmed Lubaga experience that later planting means heavier staining.

Poisoning of stainers was tried on Lubaga, using sweetened sodium arsenite solution. Last year, because of the very wet season or for some other reason, the results were inconclusive, but this year they were clear-cut ; the poisoned plots gave a crop at the rate of 915 lb. seed-cotton per acre of which 24% was stained, and the control plots a 518 lb. crop of which 52% was stained. No developmental observations were made except that the poison had no marked scorching effect on the plants, and it is not known whether the poison

acted on *Dysdercus* or *Calidea* or both. The poison* was applied once a week during the stainer season, and the practice seems to have real value under station conditions here in a dry year.

Phonoctonus spp. predators were more numerous than ever before, and may have helped to keep *Dysdercus* within bounds.

Bollworm.—American bollworm, *Heliothis armigera*, was very scarce this year both on Lubaga and in the district.

Earias spp. bollworms were no more than a minor pest. The Senior Entomologist of the Department, Mr. W. V. Harris, who visited Lubaga in April, identified the main species as *E. insulana*. *E. biplaga* was also present.

Miscellaneous Pests.—Aphis, for the first time in four years, was heavy enough to do some damage to cotton. Leaves were choked, and there was some heavy bud-shedding in early March. Ladybird and syrphid larvæ, which normally seem to keep aphis in check on Lubaga, this year lagged behind the attack ; but after a few weeks these predators cleared the plants and the crop recovered.

Grasshoppers and caterpillars in patches, both on Lubaga and in the district, infested seedling cotton. Three small cotton fields were destroyed on Lubaga. Stalk-borer in sorghum was fairly heavy as usual. Mr. Harris identified the borers (on Lubaga) as all *Busseola fusca*.

Mycology.

Stunted or disorganized plants of the " man-cotton " type were noticeable this year, although they formed, of course, no more than a negligible fraction of the population. These presumably trace back to some influence affecting last year's crop of seed.

Reddening of cotton leaves was very common this season. This reddening (definitely not some unusual expression of jassid-damage) was seemingly more spectacular than important, and may have been the result of some minor lack in the soil which is reflected through the plant only in a hard season.

Alternaria did some real damage to cotton on the farm in patches. One block of a strain trial was badly hit, early in April ; the plants held on to their bottom bolls, but shed everything else and remained stunted all season. Elsewhere, with lighter attack, leaf-shedding was followed by healthy new growth. There was a vague indication of strain variation in susceptibility. The fungus was identified, through the courtesy of the Temporary Mycologist of the Department, Mrs. Wallace, as probably *A. macrospora* Zimmern. Another of her identifications was of a *Cercospora* leaf spot, probably *C. gossypina*, plentiful but seemingly not serious on Lubaga cotton this year. Aerolate mildew, *Ramularia areola*, again patchily, was serious enough to cause some leaf-drop in May.

* 1 oz. sodium arsenite and 2 lb. sugar dissolved in 1 gall. water ; 1–2 galls. were used per acre.

District Production.

The East African programme for the season's production of food and economic crops was not finally decided until just before the Tanganyika planting season commenced and the cotton-grower did not know what was wanted of him until the last moment; cotton was finally put in the priority class, but planting plans had been upset, and the acreage was smaller and later than usual. Work had to be concentrated on food crops at the expense of cotton when the season developed badly. The lightness of the insect attack was the salvation of the cotton crop, or rather of yields, which finished at a fair level. The crop was the lowest for several years at approximately 4,000 bales; the drop in acreage was probably solely responsible. In spite of late planting and delayed cultivation, cotton was quite the most successful crop in the district this droughty season; insect attack, as has been said, was much lighter than usual, and yields per acre were seemingly average. The new stock strain of the district, Mz.561, behaved well in the field.

Approximately 12% of the total crop bought by the ginnery was "stained" grade, which means little except that the price of this grade was unusually high this year. Prices to the grower were fixed for the whole season at 12 cents. per lb. of seed-cotton for clean, and 2½ cents. for stained grade.

Summary.

General.—A light rainfall was badly distributed. Grain crops in the district were poor for the second year in succession. Cotton did well, and a drop in acreage was probably the sole reason for a short district crop of approximately 4,000 bales. Insect attack was lighter than usual; the stainer *Calidea* and late *Dysdercus* stainers caused fairly heavy staining but less loss of crop than usual. Leaf diseases were sporadically heavy on Lubaga.

Agriculture.—Direct manuring on the black loam soil seems to lead to a comparatively small if steady increase in yields, whatever the season; and the black loam soil is not easily "exhausted"; some figures are given in Appendix 1. Ridging is discussed in Appendix 2, and figures are given of its especial benefit to yield in a dry year.

Cotton Breeding.—Mz.561 replaced U.4/998 in the district and behaved satisfactorily. No strain at the bulking stage has yet shown up which can obviously better 561 in all-round qualities, but some of the newer strains may do so if they maintain their early promise. Among the introductions, the Nyasaland strain N.C.4 and the Uganda strain BP.50S6 are noted as "possibles."

Entomology.—Poisoning by sodium arsenite was effective in controlling excessive damage by stainers, judging by end-of-season results.

PROGRAMME OF EXPERIMENTAL WORK FOR SEASON 1943-44.

Inherent Agricultural Circumstances.—Yield work on the different soil-types in the district is to continue, with more attention to the " ibambasi hard-pan " type ; this soil is extensive in Shinyanga, but is not generally popular in spite of land shortage. The problems of " ibambasi " appear to be those of a physically difficult rather than an infertile soil.

Agricultural System.—Rotation trial work, including work on grass leys, is to be continued and expanded. Elephant grass is already one of the treatments in these trials. The black loams do not hold their structure particularly well under cultivation, even with fairly high (manurial) farming, and Dr. Martin of Uganda, who visited Lubaga in June, thinks such soils may respond well to the root-action of elephant grass. Elephant grass will also be tried on red loam soil in the district, as suggested by both Mr. Parnell and Dr. Martin. One of the local grasses, *Cenchrus* sp., which seems to have some promise for pasture, will also be tried. Concurrently, observation on other resting and cover crops will continue.

Partly to fit in with these developments, the district plots will be fewer but larger ; the originals were largely pilot plots, and restricted to experimental work with cotton, but the newer plots are to be permanent establishments, and will include fertility and resting-crop work.

Agricultural Practices.—Experimental work on these can be allowed to mark time ; in general, knowledge is relatively advanced here. One piece of work to be done at the suggestion of the Senior Agricultural Officer is on the effect on sorghum yields of varying the planting date : the sorghum crop competes with cotton at planting time, and has priority, but there is a need for more knowledge of the best time to plant sorghum.

Cotton Breeding.—The main branch of work on Lubaga. To continue as before, except that hybridization work will be dropped.

Pests and Diseases.—Work on insect pests is to continue as before. Stainer-poisoning will become routine practice in progeny-plots from which an assured seed supply is wanted. A range of fertilizers and minor elements—if obtainable—will be tried on Lubaga to find if their lack is responsible for upsets to foliage of cotton and other crops.

APPENDIX 1.

Fertility of the Local Black Loam Soil.—It was mentioned in last year's Introductory Note that about two-fifths of the cotton acreage of Shinyanga was on " ibushi " soil, the black loam which is typical of Lubaga. This black loam is generally accepted as a soil with good reserves of fertility. Figures in support of this can be given from the trend of yields in a cotton

" exhaustion plot " which has now been running for eight years on Lubaga. This plot, an acre, has had nothing returned and has been continuously under annual cotton since 1935–36. The fact that the strain of cotton was changed to a more jassid-resistant and heavier-yielding type in 1941, and that a much closer spacing was then adopted, should have helped to " exhaust " the plot more quickly, yet the last two years have given the heaviest yields of all : from 1936 to this year, the yields run 521, 226, 608, 248, 283, 523, 620 and 760 lb. seed-cotton. (The implied conclusion here, however, should be qualified ; growth-insect-yield interaction may be important with cotton. An exhaustion plot of sorghum—a crop less influenced by insects—seems to be showing a big decline in yields. The plants in the cotton exhaustion plot, making due allowance for the change of strain and spacing, do seem to have become shorter. Growth is still healthy. The shorter plants appear to have less attraction for those same stainers and bollworms which can play havoc with the yield in normally-grown cotton.)

As a corollary, the " exhaustion plot " figures indicate indirectly that the black loam is not particularly responsive to manuring. Positive evidence of this lies in manurial trial results. This, if ever, was a season when manuring might be expected to benefit a crop markedly. Manuring or composting however gave the same steady and useful, but unspectacular, increase in yield that seems to be the typical response of the black loam soil of Lubaga, irrespective of season : compost and farmyard manure at 5 tons per acre made a difference of 29% and 16% respectively to the yield of a good sorghum crop (trials not yet checked for significance but this does not affect the argument) ; compost on a poorish sorghum crop increased the yield by 25% ; and compost was 20% better than the control in a fair crop of cotton. These figures compare with a 21% increase (cotton) in the very wet 1942 season, and a 20% increase (cotton) in the dry 1941 season. Most of the indications are that the residual effect of manures on the black loam is small.

APPENDIX 2.

Ridging on Black Loam Soil.—Little ridging, and no tie-ridging, is practised in the district. Because of its virtual proof against erosion by water, tie-ridging is a measure as fundamentally important as manuring to the district. Observations from the time when Mr. J. G. M. King first tried tie-ridging on Lubaga show that it is practicable on these black loam soils, and the fact that it is routine practice on Ukiriguru (with " large " ridges) shows what is thought of it for granitic soils. It is probably true to say of the black loams that the immediate effect of tie-ridging is to make for much safer yields in a dry year and rather lower yields in a wet year ; the long-term effect is to preserve the soil.

Ridging is more laborious than " flat " cultivation, but this year's results removed any doubts that may have lingered here as to its value. Tie-ridging is to become routine practice on Lubaga.

Maize showed spectacular contrasts, although the general level of yield was not high. Differences between " flat " and ridging treatments were of the kind measured in multiples rather than percentages ; " flat " was virtually a failure at 153 lb. grain per acre, and " large ridges " (5′), the best of the other treatments, yielded 1,120 lb. Tie-ridges (3′) were intermediate. (The treatment " large-ridges-tied," the practice at Ukiriguru, has unfortunately not been tried here, but it is doubtless the best of all.) This

trial completely reversed the wet 1942 season's results with cotton on the same site, when " flat " significantly outyielded the other treatments, but only by some 16% on the average, a small enough penalty to pay, in the occasional year of waterlogging, for the benefits of ridging.

Cotton, this year, gave results less spectacular than maize but still well in favour of ridging: " flat " yielded 611 lb. seed-cotton per acre, tie-ridges (3') 845 lb., and " large ridges 824 lb., " flat " being significantly below the others (difference for significance 119 lb. at P.=·05).

Tie-ridging holds the rain where it falls, and the value of tie-ridging with small ridges doubtless lies in this and not in any more remote property of the ridge. With " large ridges " the value on this shallow soil may lie partly in the greater (artificial) depth of soil available to the plant.

APPENDIX 3.

Arrangement of Progeny-plots.—Most stations have doubtless their own variations of method in dealing with single-plant progenies in the field. The method used here this year—a method which seems to have some points in common with that mentioned briefly in last year's Gezira report under " Breeding plot "—may be of some general interest. Half the seed of each selection was planted in the usual progeny-plots, but the other half was planted in fairly long single rows flanked on each side by a row of standard cotton (Mz.561) whose behaviour in the field was well known. The idea was less to get a first rough estimate of comparative yield than to have some measure of the influence of soil variation on simpler points like hairiness. The expression of hairiness on the standard was assumed to fluctuate equally with that on any individual selection-row in response to the immediate soil variation. The Lubaga soil is extraordinarily patchy. At any rate, whether it was justified or not, hairiness and other characteristics of the new selections were assessed with increased confidence this year.

The standard, occupying as it did every second row, might have been used to map the fertility-trends of the field and so allow of some sort of estimate of comparative yields; but the labour involved in adjusting for the very variable stands in some 350 rows of standard and their accompanying selections, precluded that this year.

Any value the " standard " method has must depend on thorough acquaintance with the standard strain, and it is of course (at points where the two methods are alternative rather than complementary) much less objective than the Hutchinson-Panse replicated-progeny-row method. Both methods have been tried on Lubaga, and the complexity of the replicated-row system is a drawback compared to the simplicity of the other when it comes to planting and harvesting with the ingenuous labour and the one-man supervision available here. The single row, 50 feet, gives a greater vista and therefore a sounder eye-judgment (though this is doubtless a matter for personal opinion) than does a series of short, say 10 feet, scattered rows. Both methods are open to the objection that the produce is almost certainly contaminated by crossing, but the balance of seed left from an original selection is normally enough for a fair-sized duplicate plot which can be planted and selfed in the ordinary way.

NOTE ON THE COTTON WORK IN KILOSA DISTRICT, 1943

BY

A. G. BEBBINGTON.

The following is a short note to indicate the progress that has been made towards establishing the site for a new station for work on the cotton crop in the Eastern Province. It also gives a brief summary of the season's results. This last is necessarily short as there has been no time to analyse the figures and in fact the crop is still in the ground at the time of writing.

General.

Station.—As a result of the surveys of the Eastern and Northern Provinces during 1941 and 1942, and the subsequent discussion of these with Mr. Parnell and the Director of Agriculture, two areas in the vicinity of Kilosa were thought to be suitable as possible sites for a future station. Both were already occupied, one by a sisal estate of long standing, and the other recently sold by a mission but not yet cleared by the new owner. It was found to be impossible to obtain suitable land on the sisal estate. In the second area, known as Ilonga, a piece of land was obtained which was not entirely satisfactory due to lack of time to carry out a proper survey and to limitations on choice placed by the owner. An area of ten acres was finally cleared and planted to experimental cotton. During this year permission was obtained to survey the whole area. Practically all of it under consideration is covered with thick bush and has not been cultivated for some forty years. Traverses were cut through the bush and about 1,500 acres mapped by compass. A series of soil pits were also dug. As a result an area of about 900 acres has been found which would be well suited for a station site. There is permanent water near by and a suitable housing site has been reconnoitred. The question of a permanent station for cotton work remains in abeyance however, until such time as the insect pest and plant development situation has been cleared up.

In the meanwhile, sixty acres of land in the centre of the proposed site has been obtained for a period of three years and this is at present being cleared for the season of 1944.

Season.—Cotton planting in the Kilosa district begins on the European estates about the middle of February, but is mainly carried out by the native about mid-March, with some planted in April. The rains in February were good, although rather heavy, and estate cotton came away well. Rains in March were scanty and consequently a lot of the native cotton was late-planted. In April and May the rains were good. Rainfall, however, after the plant has once become established does not appear to be so important a factor in this district, owing to the presence of abundant subsoil moisture. Insect pest attack apart from stainers appeared to be generally on a lower scale than in the previous season.

Records and Experiments.

The main work of the present season, apart from the land survey just described, was the recording of insect pests in conjunction with plant development. All records had perforce to be of the simplest possible type as the native staff employed were practically all new to this kind of work. Flowering and shedding records were undertaken, but the latter had to be abandoned when shedding became heavy.

Records of bollworm larvæ on maize and cotton were taken and also of stainers and *Helopeltis* on cotton. A census of bollworm and stainer damage on weekly pickings of open bolls was carried out. The records were taken at three places :—(i) on the previously mentioned sisal estate in a large block (about 400 acres) of cotton interplanted in sisal and maize ; (ii) another large block adjacent to the experimental site at Ilonga interplanted in maize ; (iii) in a strain trial on Ilonga itself. A plot of about seven acres was also established on an estate 40 miles to the North. This plot is difficult of access in the rains and the results were valueless on account of the unreliability of the native in charge.

The first two commercial blocks were planted to maize at the end of January and interplanted with cotton about February 20th. The experimental cotton at Ilonga, late, owing to water troubles on the new land, was planted on March 23rd.

All the records showed similar flowering, which was at a low rate. While this, on the two commercial blocks, may have been, and probably was, affected by the interplanting, Local showed little increase in flowering in the normal planting on Ilonga. The crop was set over the period mid-April to mid-July and was to all intents and purposes finished by mid-October. The uprooting date is established as November 30th for the season. Features of the insect pest records will be discussed under that head.

Strain Trial.—This included Barberton 6250, Mwanza 561 and 457, MU8A, Kingolwira 553, and Local. Germination was excellent as was subsequent development, except for the low flowering rate. One marked feature was the absence of the " new land effect " commonly observed in Rhodesia. The yields were high. The figures have not been examined statistically, but they indicate the following :—MU8A led with a yield of 1,300 lb. seed cotton per acre, followed by 553 with nearly 1,100 lb. per acre. Local came last with 950 lb. per acre. The obvious point from this trial was the immediate increase in yield following upon a higher flowering rate. Local in comparison with MU8A was a slow starter and never attempted to set crop in the same way. One satisfactory point is the high yield obtained from 553, although its lint quality in comparison with Local remains to be tested. There was a suggestion that with yields of this order the lint quality of even Local was not quite up to what is recognised as Eastern Province standard.

Cultivation Trial.—The figures from this trial have not been thoroughly examined, but they indicate that a medium spacing is the

best. Wider spacings gave much lower yields and the very close spacings were also lower.

Breeding Work.

The single-plant selection from Kingolwira was planted at Ilonga together with a number of bulks. Little time could be given to these on account of the survey, but it has been possible to see some real strain differences for the first time. A number of re-selections have been made.

Insect Pests.

Records on the main insect pests were taken from February onwards in conjunction with the plant development records.

American Bollworm (Chloridea obsoleta).—Spot records taken over a number of maize crops in the district during February and March showed all crops infested to a greater or less degree with this pest. Continuous records on maize at the sisal estate and at Ilonga on maize planted at different dates showed one generation only on each planting, the last record of larvæ on maize being the middle of June. The records on cotton showed light attacks on the cotton at Ilonga with a rather more serious attack on the sisal estate. There was a suggestion that the later-planted experimental cotton had evaded the attack to some extent, a point which requires further investigation. Only one generation of larvæ was recorded.

Spiny Bollworm (Earias spp.).—This was observed in varying numbers from May onwards in all crops.

Pink Bollworm (Platyedra gossypiella).—This first made its appearance in May in very small numbers but then disappeared until the end of July. It reached very high figures in August and September. Figures of population per acre of pink bollworm are not easy to obtain as the larvæ are difficult to find on the plant. The figures obtained showed populations of between 2,000 and 3,000 per acre on the sisal estate in August and September.

Stainers (Dysdercus spp.).—Four main species were recorded :—*D. fasciatus, D. cardinalis, D. intermedius* and *D. nigrofasciatus*. One specimen of *D. superstitiosus* was taken. The most important were (i) *D. intermedius*. This appeared in numbers on all cotton as soon as flowering began and remained in the crop in varying numbers throughout the season. (ii) *D. fasciatus* was recorded early in the season, but then disappeared, returning in numbers only after the first bolls had opened. No breeding took place in either of these species until after the first bolls had opened. *D. cardinalis* and *D. nigrofasciatus* were of secondary importance. In contrast to these records, others taken on the estate forty miles to the North showed *D. cardinalis* as of major importance, taking the place of *D. intermedius*. In spite of the large populations recorded (1,200 per acre at the flowering peak on Ilonga) staining was comparatively light in the main crop. Weekly pickings of open bolls were examined lock by lock for stainer and bollworm damage. These showed very high figures for

completely rotted and stained cotton at the beginning and end of the season, but a total damage of only about 20% during the main crop, *Callidea* spp. was only seen in negligible numbers.

Helopeltis.—Records on this pest showed it to be in insignificant numbers on the two commercial crops, but it reached a peak figure of 220 per acre on the experimental cotton in July. The significance of this figure is not understood at present owing to lack of previous experience of this pest. Injury to the vegetative parts of the plant was common over the field, but very few really serious cases were seen. An attempt was made to assess the damage caused by it in open bolls. This is difficult, as there is little difference between it and that caused by stainer. The amount of damage which might be definitely attributed to it was very low, and on this year's experience the major damage caused by this pest would appear to be to the body of the plant.

Lygus spp.—Plants showed signs of damage from this pest quite early in the season but either the insect disappeared or the plants grew away from it, as an attempt to establish some kind of scale to estimate such damage was a failure due to absence of it. Much later in the season it became more obvious, but practically all plants showing injury which might be attributable to *Lygus* also showed that caused by *Helopeltis*. The damage caused by these two pests, particularly in the loss of squares, is difficult to distinguish, and no attempt was made to estimate damage caused by each.

A NOTE ON THE MOROGORO DISTRICT COTTON PLOTS, 1943

BY

A. H. McKINSTRY.

As the results of the 1943 season's work are far from completely analysed, it is not yet possible to write a full report for the 1942–43 volume of Progress Reports.

This note deals with observations and records on cotton at six district plots, and on other crops, in the Morogoro District. The supervision of the work in this area is at present done from Morogoro. The results of similar investigations in the Kilosa area, the probable main centre of future experimental work, are reported in a separate note.

Meteorology.

Rainfall for the season was very unevenly distributed. The December–January " short rains " were a partial failure ; dry conditions were prevalent during March, the main planting month for cotton by the native. On the other hand, rainfall was abundant during the last two weeks of February, and also during late April and early May. But only a few isolated showers fell after the middle of May. The

total rainfall for the months March, April and May, varied between the limits 15 to 20 inches, at the three Stations, Mgera, Morogoro and Mvomero. At Kingolwira Farm the total was only about 8 inches for the same period.

Agriculture.

The type of rainfall distribution experienced caused a delay in the planting of the principal crops through the season. For instance, maize and sorghum gardens which are normally sown in late December and in January were not planted until late January and in February. Similarly, native-grown cotton was not sown until towards the end of March and during the first half of April; this planting period was some two to three weeks later than is customary for native cotton for most of the area.

Apart from the natives' cotton, a few large acreages were planted to the crop about the third week of February by non-native farmers in the Mvomero country, an alluvial area. This is about the usual planting-time for the non-native cotton crop.

In practice, therefore, both non-native February- and native late March- and April-sown crops were grown in close proximity. This is a normal occurrence, except that this season the time between the two different plantings was lengthened by the late arrival of suitable planting rains in March.

Experimental Work.

The programme of work was designed for the taking of records, over as wide an area as possible, on the development of different strains of cotton and other crops, and also on the incidence and damage caused by the major cotton pests. The basis for this work in cotton was a randomised block trial in which six strain types were replicated six times at each District Plot. The strains planted in the trial were the two Ukiriguru selections from Lake Province Local, Mz.561 and Mz.457, Eastern Province Local and its 1935 selection K35/553, and the two U.4 types Barberton 6250 and Gatooma 9L18. In two of the trials 9L18 was replaced by MU8A, the very hairy and prolific Malwa Upland type. Where there was not sufficient seed for MU8A to be planted in the strain trial a small observation plot was grown.

Good yields of seed cotton have been obtained from most plots. The general trend of yield differences between strains so far is that all strains have given heavier yields than Eastern Province Local in the majority of cases. Also, it is particularly gratifying to record that of the Locals, K35/553 has done well, and that it promises to head the list for yield in a number of trials.

In addition to the strain trial, four of the District Plots contained a cultivation/spacing trial, and in all of them observation plots of a few strains from the Kingolwira collection, as well as the hairy MU8A and OSP16 types, were planted. The total area of the six District Plots was approximately 24 acres.

Insect Pests.

Observation on plant development of major crops which possibly influence the breeding-up of American bollworm populations, together with a certain amount of evidence on moth emergence from known pupations may be summarised as follows :—

Maize.—The bulk of the maize crop was at its most attractive (tasselling) stage to egg-laying moths during the first three weeks of April. Previous to this period smaller acreages of the crop had tasselled, while others had ripened-off during March. Records (admittedly crude) of moth emergence from known pupations of larvæ taken from the main maize crop indicate that the maize could have bred the moth population, or at least part of it, which was active on cotton.

Cotton.—The March–April-planted cotton started to flower about the end of May and produced its flowering peak over the period mid-June to mid-July. The February cotton started to flower about mid-April. Both crops were attacked by American bollworm, but the earlier February-planted areas appeared to suffer on the whole more damage from this pest than the April plantings.

Pigeon Peas.—This crop is fairly frequently grown on the headlands, and also to some extent undersown, in fields of sorghum. By mid-June the 1942 standover plants were in flower ; the 1943 crop was then at its full-bud stage. Towards the end of June and for the first half of July the 1943 crop was in full flower. It was not difficult to take American larvæ on the plants during July. On the evidence available it would seem that the pigeon pea crop does not breed up a moth population which goes on to cotton. On the contrary, as the two crops were in flower at the time, pigeon pea might possibly have shared with cotton the egg-laying by existing moth populations.

Sorghum.—This is the principal food crop of the area. The varieties in cultivation have loose open flower heads. The crop started to flower during the first week of May and its peak flowering period occurred about the third week of the month. Despite careful search over a wide area, no American bollworm were taken in this crop.

If the major insect pests are considered as a group, the damage caused by different pests varied considerably from plot to plot, and also in the commercial crops. Because of this, it must be pointed out that it is only the highlights of insect pest damage which are emphasised in the following notes.

In the February-planted cotton, plants grew out large and the crop loss which occurred was mostly about the bottom and lower middle zones of the plant-body. Bollworms, both American and Spiny, and stainers, mainly *D. cardinalis*, were largely responsible for this loss. It is estimated that yield from these areas will be about 400–500 lb. seed cotton per acre. In a minor number of instances, where a bottom crop had been set—presumably because of less

bollworm damage—heavier yields are expected. By comparison, in the April-planted commercial crops, plant growth was not as vigorous ; the crop was produced about the bottom and middle of the plant scaffold, and the proportion of grade III (dirty) seed cotton was less than from the February plantings.

In two of the district plots (at Morogoro and Kwa Dihombo) insect damage was relatively of minor importance, and crops of about 700–1,000 lb. seed cotton per acre were made throughout the plant scaffold.

In another plot (at Mgera) bollworms took a toll of the bottom and lower middle crops ; plant growth was large, woody and tangled, and capsid damage on the young leaves and shoots about the top of the plant was apparent towards the end of the season. With this type of growth it was difficult to judge either the amount of crop carried by the plants, or finer differences between strains. Yields in this plot will probably be at the rate of about 700 lb. of seed cotton per acre.

In yet another plot (at Kingolwira village) capsid damage on the young leaves and buds was very obvious almost throughout the life of the plants. Here, too, practically no bottom or middle crops were set, and plant growth was for the most part large and woody. Again it was not easy to assess strain or yield differences. Early in the season, however, the hairy types, especially MU8A and OSP16, did not show as much leaf damage due to capsid as Local strains. Yields from this plot may be about 300–500 lb. of seed cotton per acre.

Finally, at the Mvomero plot, the latest planted (6th April) of the series, bollworm and stainer populations were small ; capsid damage to the leaves became apparent about half-way through the life of the plants and, at the same time, jassid was fairly numerous. The crop was made mostly at the bottom of the plants. It was in this plot that a most striking difference was seen between the prolific and very hairy MU8A type and the Locals. The bottom to middle section of the MU8A plants was snow-white with crop, and the tops of the plants, although they carried little crop, were comparatively free of capsid leaf damage. By contrast, the foliage of local strains was tattered and bedraggled in appearance, and the plants carried a smaller early crop. It seems probable that the MU8A plots will yield about 800 lb. seed cotton per acre, or about 200 lb. more than the best of the Locals.

From the foregoing account of damage by insect pests, and other observations made through the season, the following general conclusions may be drawn :—

(*a*) Where insect damage was marked plants of all strains exhibited a woody and unattractive framework ; and where this occurred it was not possible to observe and assess finer strain differences or to judge the crops on the plants. In such

cases, therefore, the basic plant-breeding work of field observation would be handicapped. It is one of the main objects of the present work to find out just how frequently this set of circumstances is likely to occur ; and especially at Ilonga, Kilosa.

(*b*) In other instances, in the comparative absence of insect damage, it has been found difficult to make plant-breeding observations on well-grown fruitful plants spaced at $3' \times 3' \times 2$ plants per hill. Wider spacings with one plant per hill will be tried in the breeding plots with the object of facilitating observations.

Once again, it must be emphasised that as final yield figures are not yet available it may be found necessary to amplify or modify certain of the statements made in this note.

NYASALAND

COTTON EXPERIMENT STATIONS

Introductory Note

BY

H C. DUCKER.

The introduction to the 1941/42 report gave a general picture of the cotton-growing areas of Nyasaland and of the way in which the experimental work in progress is related to their problems. There is no need to repeat all that was said therein, but some emphasis on certain aspects may be permissible.

Cotton-growing developments in tropical Africa, however they may be modified in the future, will depend on the following essentials :— 1. A properly balanced agricultural development of all suitable areas, with soil conservation and efficient food crop production as the dominant factors. 2. A cotton-growing policy which is technically sound in every way, and which is carefully linked up with 1. 3. A satisfactory economic status for the cotton crop on as stable a basis as possible.

It now seems fairly certain that cotton-growing in East Africa will remain a peasant industry for the most part, and, so far as Nyasaland is concerned, this means that for many years to come the industry will be dependent on natural soil capital. It will be many years before such aids as artificial manures can be freely employed, and a long time before sound rotation cropping systems, and locally-made manures, such as farmyard manure and compost, will be generally adopted.

The present energy output of the Africans is a limiting factor of paramount importance, and an amelioration of their living conditions by every possible means must be carried out. It is for this reason that good agriculture and efficient food crop production are put before economic crops in these notes. Adjustment of agricultural practices to this end, with especial emphasis on what may be termed natural processes of soil fertility restoration, are major farming aims at Domira Bay. As said last year, a systematisation of " shifting cultivation," by use of " bush fallows " under proper control and of " rest crops," is the practical line of approach to soil fertility problems.

It must be admitted that many of the limiting factors to large-scale cotton production in Nyasaland at present are outside our proper field of work, and in some cases are beyond the control of anyone locally. One can only tackle the problems that one can reach.

Agriculturally speaking, we can see quite a long way ahead on certain lines, especially in the " winter crop " area of N. Nyasa, and in the " summer crop " areas of Central Nyasaland, where pest control

is already fairly efficient ; but until a clear lead is given us, by the resolution of the red bollworm diapause problem, no stable cotton-planting technique can be adopted in the Lower River areas, where the agricultural situation remains precarious.

After giving in 1942 one of the best cotton crops they have ever produced, in 1943 the Lower River areas gave a very poor return, due almost entirely to red bollworm damage.

All members of the staff were on duty throughout the year, and postings were as stated last year.

The generous help given to Mr. Pearson by the Nyasaland Government, in supplying facilities for his critical work on red bollworm diapause by providing laboratory and other accommodation at Zomba, is greatly appreciated, and Mr. Mitchell's move to Limbe has helped very much to make easier the Lower River field work.

The ready assistance given to the members of the Plant Breeding and Agricultural Section by the Public Works Department, on the occasion of the tornado which wrecked certain buildings at Domira Bay, is gratefully recorded.

DOMIRA BAY STATION

PROGRESS REPORT, 1942-43

BY

H. C. DUCKER AND W. L. MILLER.

METEOROLOGY.

The total rainfall for the season was 36·83 inches, very little more than that of 1942, and except for an excessively wet spell occurring in January this year, instead of March as happened last year, a very similar distribution.

The planting rains broke on December 6th, and the last effective shower of rain was on March 24th.

It has been our custom in the past to complain about such early truncation of the rains, but the records of the last thirteen years show that this has happened eight times during that period in greater or less intensity. A short period of effective rain, some fifteen to sixteen weeks, seems usual at Domira Bay, but the total amount of rain received in any year does not vary much. The maximum range to date is from 28·37 inches in 1935, to 36·83 inches this year, and the mean for thirteen years is 32·77 inches per annum.

An unusual feature about the break of the 1942/43 rains was the occurrence of a tornado which did considerable damage to certain station buildings. One house, fortunately unoccupied at the time, has since had to be demolished, so badly was it damaged.

Agriculture.

Cotton.—There was no main station bulk this year, but allowing for low seed rates and consequent faulty stands in various increase plots, yields were comparable with those of the " 920 " bulk of 1942, and the fields used for cotton were also comparable in fertility with those used for that bulk.

Hoeing conditions in January were very difficult indeed. There were only three days during the month when no rain fell, and even on the Station it was a hard business keeping weed growth in check. In the districts nearby the Africans were heavily handicapped, and their food and money crops show shortfalls in consequence.

It has been a poor year for the large-scale commercial trial of U.4–920 bulk. This cotton was grown in Dedza, Dowa and Kotakota districts of the S.W. Lake shore area. Several markets failed to reach their estimates, but some very good individual yields were recorded in all areas. It is not, however, now thought that this cotton is any real improvement on the Crown Land Commercial U.4.

All plots in the 1941/42 maize/groundnut experiment were planted with Mz.561 S.B. cotton, in order to study residual effects on a proper experimental basis. Results were as under :—

	Yields seed cotton, lb. per acre.
Cotton following Maize, pure stand	535
„ „ Groundnuts, pure stand	551
„ „ Maize and groundnuts grown in alternate rows	520
„ „ Maize and groundnuts intercropped in same rows	515

The differences are statistically insignificant and no adverse effects of groundnuts on cotton were demonstrated.

Two standard strain trials were completed, and their results are summarised as under :—

Yield Comparisons are in Terms of Seed Cotton, with Crown Land Commerical U.4 = 100 as Control.

Trial		
A	Mz.561.S.B.	133
A	C.L.72	119
A	C.L.119	119
A	C.L.177	115
A	C.L. 85	114
B	N.C.4	110
A	C.L.93	105
B	Barberton 0268	103
A	C.L.123	102
A	C.L. 68	101
A and B	Control	100
A	C.L.20	100
B	N.C.12.	94
B	Ukerewe Ilangala	94
B	920–1	94
B	N.17	94
B	920 3	92
B	" 920 " Local	91
B	" 920 " Barberton	88

Significant differences.

Strain Trial A.

15 ... ... P.=0·01
11 ... ... P.=0·05

Strain Trial B.

17 ... ... P.=0·01
13 ... ... P.=0·05

The two trials were grown side by side in the same five-acre field.

The outstanding result is the success of Mz.561 special bulk, which even with its somewhat lower ginning outturn is easily the best lint producer.

It is interesting to review the results with this cotton over the past three seasons at Domira Bay, using the same comparison as above, Crown Land U.4=100, in the various strain trials.

1941.	Mz.561 original mass selected bulk	113
1942.	Mz.561 as above	118
1942.	Mz.561 S.B. Special mass selection	134
1943.	Mz.561 S.B.	133

The original mass selection was derived from the original (1939/40) importation of seed, grown in wide spacing and heavily rogued, and the special mass selection was obtained from this by further heavy roguing of jassid-susceptible plants in one acre of the 1941 bulk.

Mz.561 is to be given a commercial trial on an estate owned by the African Export Corporation Ltd., near Golomoti in the S.W. Lake shore area. If successful, seed from the resulting crop will be used in a more extended commercial trial in one or more neighbouring market areas, and may ultimately be used for general commercial purposes. It can be followed up by one or more high-yielding derivatives now being bulked at the Station (*see* Genetics and Plant Breeding Section below) if their lint qualities prove satisfactory.

Strain Trial B contained a repetition of the " mutual trials " being conducted in co-operation with Barberton of U.4.920 and certain derivatives from this cotton.

Once again there were no significant differences between locally re-selected " 920 " and Barberton " 920 " in yield at Domira Bay, though in both years the local cotton has given a slightly higher yield. The spinning tests on the 1942 lint samples from these trials showed that though the Domira Bay lint is generally comparable with that produced by " 920 " in previous years, it fell below that produced at Barberton in spinning quality.

U.4.920 evidently suits South African conditions better than those of Nyasaland, even after several years of re-selection here.

It is too early to make any comment on the new " rest cropping " experiments which have been laid down this year. These were mentioned in the 1941/42 report, and are designed to augment the information provided by the long-term rotation experiment now concluded. All the " new rest crop " plots were successfully established.

In order to have some information about the sequence of crop formation and loss, flowers were tagged systematically in both strain trials, during the main period of crop formation, and their subsequent fate recorded.

Strain Trial A.	*Strain Trial B.*
Total taggings 6,000 ; Total losses 4,751.	Total taggings, 6,000 ; Total losses, 4,448.
Losses due to bollworm, 2,222 = 37% of total.	Losses due to bollworm, 1,960 = 33% of total.
Losses not due to bollworm, 2,529 = 42% of total.	Losses not due to bollworm, 2,488 = 41·5% of total.

It is believed that red bollworm control by close season measures was at least as good as in previous years, and that with a stable cotton acreage at the Domira Bay Station we are also dealing with a relatively stable pest population. It is to be hoped that this is so, since on it depends in large measure any attempts to breed for higher yields.

Few of the flowers tagged as late as April 10th gave sound bolls which opened properly, and little flowering after this date was effective. The main crop-producing period was confined to the flowering of the five weeks ending April 3rd.

Rotation Crops.

General.—The main rotation is continuing on the plan laid down in the 1941/42 report, and needs no special comment. It appears to provide a good balance of crops and only protective foods such as green stuffs are lacking. Reference to new attempts to provide these for our labour is made below.

The fields containing the twin cultivation experiments went to " rest " last year and the experiments have been dropped for the present. A new maize cultivation experiment designed to compare European and Native practice has been begun. This forms part of a series of similar experiments carried out at various places in the Northern Province and will be a long-term business. It is being done in co-operation with the Department of Agriculture, and will be reported upon in due course.

The groundnut rotation experiment has been carried on to its third year. No adverse effects of groundnuts on cotton were observed in this year's plots.

The residual effects on maize of the large-scale rotation experiment were tested and form the concluding phase of this work, since the fields used now go to " rest." Results are summarised below :—

	Yields in lb. grain per acre.	*Sig. Diffs.*
3 years' rest under Elephant grass	2,088	
2 " " " "	1,614	139 lb. P.=0·01
2 " " Pigeon peas	1,401	
1 year rest under Pigeon peas	1,569	105 lb. P.=0·05
No rest at all	1,245	

The value of three years of rest is again very obvious, and the only doubt is whether a longer period would not be even better. This will be resolved in due course in our new " rest cropping " experiments.

The one year's rest under pigeon peas gave a discordant result, which may have been brought about by the effect of cotton on a following maize crop, but the general contentions on which our present rotation is based are unassailed.

Maize.—This crop suffered from the wet spell in January and produced, at seven bags per acre, only about two-thirds of our normal crop. The Africans' crop in the district did even worse and there is a

threatened food shortage near Domira Bay. Fortunately for our labourers' food supply our maize acreage was larger than usual owing to the readjustments made in the main rotation in 1942.

A maize spacing experiment, designed to show the effect of "bunch" planting compared with other arrangements gave inconclusive results. The fertility gradient in the field used for this experiment was very marked, yields increasing steadily as one proceeded down hill. This is one of the oldest fields on the Station and the fertility drift has occurred in spite of ridge terracing.

The five years' soil restoration experiment, wherein maize will be used in the continuous cropping plots as the exhausting crop, has been referred to above. This experiment when completed should shed much light on the problems presented by the local native practice of running down land under maize continuously planted, and will help us to a decision on the merits of a four-year rest period.

Groundnuts.—The season suited this crop, even though the fields were temporarily swamped with weeds in January, and high yields were recorded. The mean yield per acre over the entire area of 32 acres under groundnuts was 1,760 lb. nuts in shell per acre—roughly 1,173 lb. kernels per acre.

Gambia Bunch was used on the main acreage and in addition one acre each of our collection of varieties was grown.

A groundnut digging experiment, using five digging dates, was done. The dates were at weekly intervals commencing with that on which the bulk of the crop appeared to be ready for harvest, roughly 98 days from planting for the Gambia Bunch variety used. Only 0·53 inches of rain, in small showers, fell during the digging period. The second date of digging, 105 days from planting, was significantly the best, but the third ran it very close.

With bunch varieties digging must be done soon after the nuts ripen for best results, and it is for this reason that slowly-maturing runner types are preferred by the Africans even though they give lower yields. Digging can be done in more leisurely fashion.

A "uniformity trial" was harvested using an evenly-grown acre of Gambia Bunch free from ant heaps and other obstacles. The statistics are yet to be worked out, but preliminary study suggests that long single-ridge plots (two rows by 110 yards in our normal practice) will prove satisfactory for strain trials and other experiments.

Pigeon Peas.—A large area, seventy acres, was planted with this crop under the new "rest" scheme of the main rotation, and given a light inter-planting of elephant grass, cuttings being planted at about $6' \times 3'$ spacing.

A very good stand was obtained of both crops, and the pigeon peas have grown well, even on fields which in previous years had suffered wilt damage. One can only imagine that the rotation wherein there

is a five-year interval between succeeding crops of pigeon peas, is effective in controlling the wilt. A good first crop of seed has been harvested from the pigeon peas.

The combination of pigeon peas and elephant grass gives a very efficient continuous cover, and good control of annual weed growth. It is also valuable in that the grass regenerates well under natural conditions, either from stolons or seed, after fire, while it fills the places left bare by the gradual dying-out of the pigeon peas in their third year from planting.

A fire accidentally invaded one " rest crop " area this season and though the pigeon peas were killed the elephant grass has survived and is now making good new growth. This area was second-year " rest " and the grass which had grown through two rains was well established.

Miscellaneous Crops.—The usual assortment was planted and several new introductions were added this year.

Of the latter, *Broom Corn* planted at the request of the Department of Agriculture gave some good heads, but was heavily attacked by a species of Rust.

Cluster Beans from Tanganyika grew and fruited well, and show considerable promise as an inter-crop either in the orchards or in maize. Their pods in the green stage are said to have a particularly good food value and to be most appetising. The seed obtained will be bulked next year for further trial.

Soya beans, new seed stocks of which had been obtained, again gave very poor results. This crop appears to require more temperate conditions of climate than Domira Bay can provide.

The new citrus orchard at No. 2 borehole has been established and is growing well. Losses in transplanting from the 1942 nursery have been very small. This orchard, mainly oranges and tangerines, will be used to supply a regular citrus ration to our labour force.

Tanks and Dams.

The soil and climatic conditions of Domira Bay make the provision of protective foods, greenstuffs and the like, for the labour employed on the Station, a very difficult matter in the dry season. (The desiccation is such that even prickly pear, a bad pest in some countries, has only survived here with the help of hand-watering.) Only in " Madimba," naturally sub-irrigated areas, or on land which is irrigated in some way, can they be grown successfully. Madimba are lacking in the Station lands and irrigation from the boreholes is slow and expensive.

Since there is broken land, to the north and south of the cultivated areas, which lends itself admirably to dam making, it was decided to experiment with this method of storing surface storm water. Two dams have been built this year which it is hoped will work satisfactorily, and they will be reported upon in due course.

If successful and reasonably trouble-free they will open up some useful possibilities.

The Africans in this area seem to like the idea of surface dams as it is something they can build for themselves with a modicum of skilled supervision. An extension of the dam scheme to Crown lands would do much to develop this area.

Cotton Genetics and Breeding.

No small bulk trial was planted this year, and the senior author of this report regrets now that he lacked the moral courage to use the single-plant material of the Mz.561 selections partly for this purpose.

Thirty-five selections from Mz.561 were grown in progeny lots in a compact block of 35 rows × 110 yard at standard spacing, three plants per hole at 3′ × 2′. All did very well and only one was doubtful for jassid-resistance under this year's conditions.

Yields were high on the season's standards, averaging over 600 lb. seed cotton per acre. The best progeny lot yielded at a rate over 900 lb. seed cotton per acre.

Lint from all has been sent to Didsbury for examination, and as many field and laboratory records as could be managed have been made.

Most of these selections will be put into small bulk next year and tested in strain trials.

The mean ginning outturn was 32% using a roller gin, and 30% using a sixteen-saw gin. Whether it will be possible to improve on these figures has yet to be ascertained.

The spinning test material sent from the 1942 small bulk trial was unfortunately and regrettably marred by faulty ginning. In an attempt to imitate commercial ginning our forty-saw gins were used for these small lots. The gins are now rather ancient and their breast bars are worn, and much seed coat material passed through with the lint as well as rather more seed than is strictly desirable. The Shirley Institute reported that the samples were exceedingly troublesome to process and spin.

However, though strengths were rather more variable than is usual, the sample yarns are comparable *inter se*, and the laboratory tests are relatively unaffected.

Two of the Crown Land selections, C.L.20 and C.L.119, were most promising. They combine good jassid-resistance with excellent lint, and other good qualities, but C.L.20, a very heterozygous lot, showed marked susceptibility to Blackarm disease. In the wet spell in January over 46% of its plants showed stem lesions. This disease, which rarely becomes serious in Nyasaland, was rife in January over our entire cotton acreage.

The opportunity was taken to obtain a statistical comparison between the relative susceptibilities of our cottons, by counts in the two strain trials, and the C.L.20 lots were thoroughly rogued, all plants showing bad stem lesions being uprooted. From the survivors a very large number of single-plant selections have been made.

Apart from the C.L.20, few of our cottons showed as many as 20% of plants with stem lesions, and it is not thought in any case that Blackarm will ever become serious in this country with our long dry season. Mz.561 showed fair resistance and C.L.119 was hardly affected at all.

Ukerewe Local and Ukerewe Ilangala stocks, the parent bulks from which Mz.561 was derived, were grown in fairly large plots and heavily rogued for jassid-susceptible plants. The resulting special bulks will be examined next year for possible single-plant selections.

The various N.C. lots, U.4×Cambodia×U.4 crosses made at Domira Bay, did well in small bulk, but the two planted in the strain trials were not particularly outstanding. They are, however, an improvement on " 920 " and will be retained.

The *religiosum* cottons supplied by Mr. J. B. Hutchinson were planted in progeny lots on an isolated plot which could be irrigated.

Some failed to germinate, but of those which did several proved fairly tolerant to jassid. The others were very susceptible indeed and only produced small shrivelled plants. None of the surviving jassid-tolerant strains flowered before the third week of April.

Since they were planted on December 21st last, we have in them some real " delayed action " cottons, which may provide useful breeding material for the Lower River if plant breeding has to come to the aid of the entomologists in the elucidation of the red bollworm problem.

Unfortunately, these *religiosum* cottons have very small bolls, their lint is short-staple, and their ginning outturns very low. Their plant habit also leaves much to be desired.

Summary and Conclusions.

Another year of difficult conditions has been experienced, but it is pointed out that a truncated rainy season appears to be not unusual at Domira Bay. The actual amount of rain received does not vary much from year to year.

The merits of a three-year " rest " period for the restoration of soil fertility have been confirmed for maize as well as for cotton, and work has been begun to see if four years might not be even better.

The fears expressed in 1942 about cotton/groundnut relations in a rotation have not proved justified so far.

Mz.561 cotton has come to the fore at Domira Bay as a leading variety, and its possibilities are being thoroughly explored.

N.C., a cross made at Domira Bay, is proving a fair performer and may be useful if the U.4 style of lint is to be retained in Nyasaland.

Certain Crown Land selections are proving satisfactory, and work on two of them is being intensified. They combine fine lint and good jassid-resistance, though one was rather susceptible to Blackarm disease.

The close season measures for the control of pests were a success for the sixth year in succession at Domira Bay, though it might be wise to say that this is purely relative.

PROGRAMME OF EXPERIMENTS, 1943-44 SEASON.

Strain Trials.—A strain trial or trials to compare the new Mz.561 selections and other cottons will be carried out.

Increase Plots.—The new Mz.561 selections will be grown as self and natural increase plots. The N.C. and other stocks will also be maintained.

Breeding Plots.—The re-selections from C.L.20 and C.L.119 will be planted in progeny rows. Ukerewe cottons will be grown for selection purposes and certain new crosses from Barberton will be grown in observation plots.

Rotation Crops and Experiments.—All the current experiments and certain new experiments will be done as well as labour and other facilities permit.

Investigations into the problems presented by the dams will be commenced.

Any requests for special work by the Insect Pest Control Section will be met if possible.

ENTOMOLOGICAL WORK

PROGRESS REPORT, 1942-43.

LABORATORY AND STAINER WORK (E. O. PEARSON).

General.—Experimental work was transferred to Zomba in September, 1942, and by December the necessary apparatus was installed and working. An inner room in the Department of Agriculture building has been adapted to be maintained at any desired constant temperature or humidity, and a range of temperatures is

obtained by a multiple temperature incubator housed in the same room, containing 15 compartments each of 1 cu. ft. capacity. Extremely constant temperatures can be maintained in this apparatus and its large size enables big samples of material to be used. The whole equipment is electrically operated and controlled and has been made locally to our own design.

The Nature of Long-Term Development in Red Bollworm.—In previous reports the importance has been stressed of that part of the pupal population which, instead of starting to develop immediately after formation, enters a resting stage from which emergence may not take place for many weeks or even months. Such pupæ have been variously described as "long-term," "diapause" or "non-developing" pupæ.

The recommencement of emergence from such pupæ has been referred to as the break up of the diapause and attempts have been made to correlate this with climatic factors ruling at the time. Unsuccessful attempts have also been made to induce this break up of diapause artificially, by submergence in water, exposure to low temperatures and other devices. It has, in fact, been thought by us that resumption of normal development in such pupæ is dependent on some external stimulus.

A study of the course of events when all possible external stimuli are eliminated, by incubating pupæ at constant temperature, has revolutionised this conception. Pupæ obtained from field-collected 5th instar larvæ in September, 1942, were removed to Zomba and incubated under three different temperature treatments :—(A.) Room temperature continuously.* (B.) Alternating medium and high temperatures. For the first 13 weeks the alternatives were night room temperatures (mean 24°C.) for 16 hours, and 37°C. for 8 hours, subsequently 30°C. for 16 hours and 39–41°C. for 8 hours daily. (C.) High temperature, 37–38·5°C., continuously.

After 13 weeks these three main treatments were subdivided, a sample being removed from each and incubated at a constant temperature of 30°C. Humidity was not specially controlled in this experiment, but it has been shown that this has no effect on pupal life (Mitchell, *E.C.G.C. Repts. from Expt. Stations*, 1941–42, 159).

The results of these experiments are shown in Fig. 1, where the running total of moth emergence (expressed as a percentage of the original pupæ) is plotted against the number of weeks from the date of pupation. Smooth curves have been drawn through the weekly values and to avoid overcrowding the actual values have only been shown at the 5-weeks' intervals.

* Mean room temperature over the period September–April inclusive, in which emergence took place from 89% of the long-term pupæ, was 25·4°C., the monthly means varying from 24·7°C. in September, to 26·7°C. in November. The diurnal fluctuation was of the order of 5°C. The results may fairly be taken as not widely different from what would have occurred at a constant temperature of 25°C.

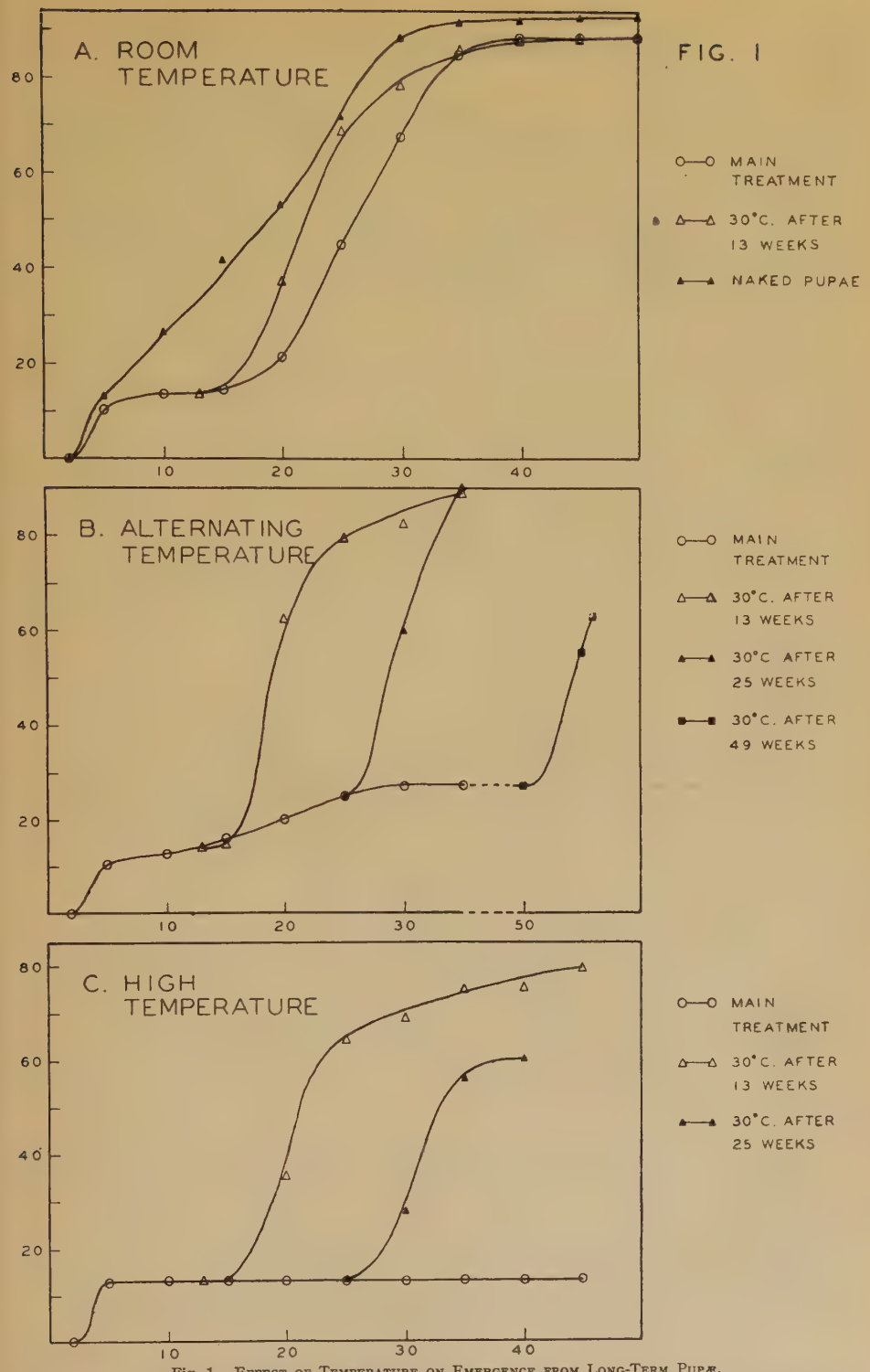

FIG. 1

Fig. 1. Effect of Temperature on Emergence from Long-Term Pupæ.
Ordinates: Emergence as cumulative percentage of original pupæ. Abscissæ: Pupation period in weeks. Main Treatments: A, Room temperatures throughout. B, Room temperature, approx. 24°C., for 16 hrs. alternating with 37°C. for 8 hrs. daily (weeks 0–13); subsequently 30°C. for 16 hrs. and 39–41°C. for 8 hrs. daily. C, Constant temperature 37–38·5°C. throughout. Samples of surviving pupæ removed to constant temperature of 30°C. after 13, 25 and 49 weeks.

Considering Fig. 1, A, the sharp rise at weeks 3–5 represents the emergence of the short-term fraction. Thereafter no emergence occurs until week 16, after which the emergence follows a sigmoid curve, the only difference between that at 25°C. and that at 30°C. being that the latter is steeper than the former. This shape of curve clearly represents the cumulative moth emergence from pupæ whose period of development is a frequency distribution approximating closely to a curve of normal error with a mean at 26 weeks (25°C.) or 22 weeks (30°C.).

Emergence of this character in an approximately constant environment shows that the pupal period of long-term pupæ is pre-determined, the individual variations in length of time representing variations in the intensity of the factor operating on the larvæ to cause long-term development and/or the expression of genetical variability of the larvæ.

Attempts to "break" this slow development and induce short-term emergence, by exposing pupæ to very low temperatures (8°C. and 12°C.) for several days and then returning them to 30°C., or by incubating them at temperatures alternating daily between 16°C. and 30°C., were not successful, the only effect being a retardation of the slow development proportional to the length of exposure to low temperature.

Nevertheless, the temperature conditions under which this slow development takes place evidently do affect its rate, the mean period being significantly less at 30°C. than at 25°C. This suggests that, although no *visible* development takes place until the last three weeks of life, the long-term pupa is in fact undergoing slow physiological change throughout its life, at a speed which fundamentally is pre-determined by its larval history, but which may be accelerated or retarded by the temperature at which it is kept.

Developmental Limits of Long-Term Pupæ—High Temperature.—If the various main treatments, A, B and C, in Fig. 1, are considered, it will be seen that in each case approximately 13% of the pupæ emerged as short-term ones. In point of fact these pupæ had already undergone 3 weeks at normal temperatures before the main treatments were applied and hence the bulk of these emergences were not really subjected to high temperatures.

The effect of high temperatures on the long-term pupæ was profound: only 15% more pupæ succeeded in emerging at the alternating temperature, whilst the continuous high temperature completely stopped any further emergence. High temperatures of the order used evidently have an effect on the physiology of the pupa which extends beyond the actual period during which they are applied, since pupæ in treatment B, although enjoying 16 hours a day at a favourable temperature, were unable in the majority of cases to take advantage of it. A possible explanation would be that during long-term development a moulting hormone is slowly being secreted which, on reaching a sufficient concentration, induces emergence,

but that this substance is destroyed by heat and thus, in the case of pupæ subjected to diurnal fluctuations into the critical temperature zone, never reaches the required concentration.

Pupæ subjected to the high temperatures retained their normal appearance and their viability was tested at intervals by removing samples to a constant temperature of 30°C. The emergence curve of such samples closely resembles that given by non-heat-treated pupæ developing at 30°C., irrespective of the time for which the pupæ have previously been conditioned. The sigmoidal character is not so well shown, but this is probably due to the relative smallness of the samples used. Pupæ which have been subject to fluctuating high and medium temperatures, however, develop more rapidly after such treatment, and the more prolonged the conditioning the more rapid the subsequent development. There is a suggestion of the same effect in pupæ conditioned at a constant high temperature, but it is not statistically significant in this case. The data show that, in general, the effect of high temperature is completely to arrest slow develoment of long-term pupæ, the pupæ resuming development as soon as the inhibiting influence is removed.

This theory of slow development, however, whilst satisfactorily explaining the results of subjection to high temperature of pupæ aged 3 months or more, does not apply to younger pupæ, for reference to Fig. 1, A and C, will show that pupæ which had been 13 weeks at high temperature and those which had been kept at medium (room) temperatures for the same period both started to emerge at the same time and at roughly the same rate, when brought to temperatures within the developmental zone.

This fact suggests that there are two phases in the life of the long-term pupa, of which the first, which may be called the quiescent phase, is insensitive to temperature, in the sense that, provided the temperatures applied are not actually lethal (*q.v.*), it makes no difference to the total pupal period whether this phase is passed at high or at low temperature. The second phase, which may be called the slow development or hypometabolic phase, is sensitive to temperature: development may be completely inhibited by exposure to high temperature or, as will be shown later, to low temperature, whilst at intermediate values the rate of development varies with the temperature. To be exact, one should add a third phase, that of visible development, corresponding at the same temperatures to the development of short-term pupæ both in duration and appearance.

The fact that visible development started in the earliest emerging long-term pupæ very shortly after their removal from the high temperature conditioning shows that the quiescent phase must be of the order of 3 months in duration, and other considerations point to there being little difference between pupæ in this respect.

Low Temperature.—The only results available at the time of writing are from long-term pupæ exposed to low temperatures when

already over 6 months old, from a population which was approaching the completion of its emergence. The rate of emergence of these pupæ was significantly retarded below 26·5°C. and completely arrested below 16°C. Pupæ whose development had been arrested for 3 months at 12°C. and 16°C. subsequently developed at the normal rate when returned to 30°C. The effect of arrest of development at low temperature, in fact, seems much the same as that due to high temperatures.

Lethal Temperatures for Long-Term Pupæ.—The highest constant temperature so far tested at which slow development has been suppressed without the pupa being killed is 38·5°C., but pupæ subjected to 41°C. for 8 hours a day over several months have not succumbed. Temperatures of 50°C. and over were fatal to long-term pupæ which had already started development (humidity not controlled, but probably fairly high). Exposure of long-term pupæ when 6 weeks old to temperatures of 45°C. for 48 hours was fatal, at both 19% and 88% R.H. The percentage loss in gross weight was 12·7% and 1·7% respectively at these humidities: it is calculated that losses of the larger order might cool the pupa by about 1°C. More detailed studies of the lethal point are now in progress. Temperatures as low as 8°C. do not appear to be lethal.

Rate of Development of Short-Term Pupæ.—The rate of development of short-term pupæ (*i.e.*, the reciprocal of the pupal period), when plotted against temperature gives a straight line, over the range 22·5°C–33·5°C.

Above this range the rate of change of velocity diminishes, the pupal period approaching a limiting value of about 11 days. The maximum pupal period observed, at 21·5°C., was 31 days.

Between 15°C. and 20°C. development seems to go on, but so slowly that pupæ usually die, either from desiccation or from moulds, before moths emerge; below 15°C. development is completely arrested, but may be resumed on return to a favourable temperature; temperatures as low as 8°C. had no lethal effect. An extremely interesting point, which has not yet been properly investigated, is that short-term pupæ, if subjected for a long period to low temperature (8°C.), may not resume normal rapid development when returned to a favourable temperature, but instead behave as long-term pupæ. Only a few cases of this have been observed.

The highest temperature at which development took place was 36°C.; at 38°C. development was arrested, but could be resumed when the temperature fell; at 41·5°C. pupæ were killed. A few cases have been seen where short-term, heat inhibited, pupæ have not resumed their short-term development when returned to lower temperatures, but have behaved as long-term pupæ.

Comparison of results obtained with pupæ approximately 5 days' old when treatment started, with those obtained from pupæ treated as soon as formed, suggested that once development has started it

cannot be arrested in the usual way by high temperatures—the pupa continues to develop, but the moth is usually killed before eclosion. Death may be due in these cases to excessive water loss, control of which seems to break down in developing pupæ.

Relation of Temperature to the Formation of Pupæ.—Fully-fed larvæ collected in the field in April were placed in jars of soil at different temperatures, the moisture contents of the soil being in all cases suitable for pupation. Normal pupation took place over the range 21·5° C. to 36°C. ; above and below those temperatures the proportion pupating successfully fell sharply and at 16°C. and below, and 41·5°C. and above, larvæ were unable to pupate. The temperature during the formation of the pupæ did not affect their character, all of them being short-term, as was expected with pupæ at that time of year.

Variability of the Pupal Population.—It has already been shown that the population is extremely variable as regards the pupal period of long-term pupæ. The actual values of the means and the standard deviations of the distributions of pupal periods are 26·1 and 5·3 weeks respectively, for pupæ incubated at 25°C., and 22·3 and 6·0 weeks for pupæ incubated at 30°C. The same variability is shown in all temperature reactions, being particularly noticeable as regards the upper critical temperature. This accounts for the phenomenon, always prominent in the field pupation cage records, of a proportion of very short-term emergences amongst September–October pupæ, at a time of year when soil temperatures are inhibiting the development of the greater part of the pupal population.

Behaviour of Pupæ With and Without the Pupal Cell.—All the results which have been described so far relate to pupæ intact within their earthen cells, as they occur naturally. The removal of this cell has the effect, in general, of significantly shortening the pupal period. In the case of long-term pupæ (arbitrarily defined as those with a pupal period of more than 10 weeks) incubated at 30°C., the mean pupal period was shortened by 4 weeks ; at room temperature (mean approx. 25°C.) the effect is greater, about 5 weeks. In short-term pupaæ the effect, though recognisable, is small. These results must be taken as superseding those previously reported (*Repts. from Expt. Stations, 1941–42,* 160), which were based chiefly on short-term pupæ. A re-examination of these data showed that, where emergences were grouped by months, heterogeneity could be demonstrated even here, there being significantly more emergences in the earlier months amongst the naked pupæ.

A further effect of the removal of the cell is that the distinction between short-and long-term pupæ becomes much less pronounced, giving the practically continuous emergence shown in Fig. 1, A.

The fact that this difference in behaviour occurs in constant temperature conditions disposes of the theory that, under the rather low fluctuating temperature conditions in which the phenomenon had previously been observed, the lagging effect of the earthen cell was

sufficient to deny the enclosed pupa the benefits of small diurnal rises into the range of developmental temperatures enjoyed by the naked pupæ. Direct measurements of the rate of change of temperature within naked and enclosed pupæ, exposed to rapidly changing external temperatures, showed that even with changes of the order of 3°C. per minute, the lag within the enclosed pupa was at most 45 seconds.

The earthen cell and its silken lining is not gas-tight, and sealing the pupa by covering with a film of paraffin wax, results in its death. Nevertheless, the porosity of the firmly cemented structure must be very low, and the work of Penman (*J. Agric. Sci.* **30**, 577, 1940) on the relation between the coefficient of diffusion of gases through solids and the porosity suggests that the cell wall, by lowering the rate of diffusion of carbon dioxide out of the cell, and oxygen into it, may maintain an excess of the former and a deficiency of the latter sufficient to retard pupal development.

The effect, however, is not noticeable in the latter stages of pupal development, since removal of the cell wall in January from long-term pupæ formed the previous year made no difference to the emergence of the fraction then remaining. It is possible that the effect is mainly in the partial elimination of the quiescent phase of long-term pupæ. Work is being continued on this effect, which, although due to a purely artificial circumstance, may throw light on the processes at work in the long-term pupa.

Seasonal Variation in the Production of Long-Term Pupæ.—In order to find the proportion of long-term pupæ produced in the field at different times of the season, freed from the complicating effects of soil conditions on pupal life, weekly field collections of fully-fed larvæ were removed to the constant temperature room after they had pupated, and their emergence studied in this constant environment.

The data are still incomplete and can best be expressed at the moment as the percentage of short-term emergences from the weekly samples. As mortality is not large (less than 10%) and is pretty constant from one sample to another, the balance may be taken to be potential long-term pupæ, not all of which, however, will succeed in emerging. The percentage of short-term pupæ starts high (90–99%) and remains so until mid-May, after which it falls away in an irregular manner, reaching 35–40% only in August and early September pupæ. These results abundantly confirm that the proportion of short-term emergences observed in the field pupation work depend upon circumstances experienced before the pupa is formed.

Pupæ Bred under Controlled Conditions.—From all the foregoing it is clear that whether a pupa will develop as a short- or a long-term one is determined by factors operating on it before the pupal stage is reached. In attempts to induce long-term development, artificially-bred larvæ have been produced under various conditions in the laboratory. Contrary to expectation it was found fairly easy to carry larvæ through to pupation ; the success of the method used

is thought to lie in the close control of temperature, which, by preventing diurnal fluctuations, avoided condensation of moisture inside the breeding jars, and in the control of the humidity in the latter at a rather low value (70% R.H., obtained by saturated solutions of NaCl).

Unfortunately a serious difficulty was experienced in obtaining fertile eggs under laboratory conditions, and owing to the failure of the egg supply to synchronise with availability of food the experimental programme was badly hampered.

The following results, however, were obtained :—

(i) Larvæ bred at constant temperatures of from 23°–33°C. produced short-term pupæ, irrespective of whether they were fed on buds, or on bolls up to 6 weeks of age, and whether derived from eggs laid by moths from short-or long-term pupæ. In all cases eggs were laid and incubated at 30°C. There were three exceptions to the above, out of 131 pupæ obtained : two of these died, without starting to develop, after 4 weeks, and one emerged at 64 days.

(ii) Of small numbers of larvæ successfully reared on buds and green bolls at fluctuating temperatures (30°C. alternating with 8°C. or 12°C.), or subjected to low temperatures (19°C.) or high temperatures (38°C.) for part of their life, 26 gave short-term pupæ and 3 gave pupæ with lives of 29, 34 and 80 days.

(iii) Pupæ incubated at 38°C., derived from larvæ fed on mixed food at 30°C., did not start development unless removed to 30°C. again, when normal short-term development ensued, except in the case of one pupa so treated, which emerged after 62 days.

The effect of feeding on bolls which are fully mature could not be tested, but it seems unlikely that such a source of food is primarily responsible for long-term development, since the field-collected larvæ from which our long-term pupal material for experimental work is obtained are mainly found in bolls which are still immature. The experimental results show clearly that it makes no difference to the type of pupa produced, whether the larva is fed on buds, small bolls, or full-sized bolls up to 6 weeks of age. Constant temperatures within the developmental limits nearly always gave rise to short-term pupæ. The only suggestion of the induction of long-term pupæ comes where larvæ are checked at some point in their development by exposures to temperatures outside the developmental limits.

Although there is no suggestion of an alternation of generations, *i.e.*, short-term pupæ giving rise to long-term ones, and *vice versa*, the odd cases of long-term pupæ arising in uniformly treated batches giving short-term pupæ suggests that there must be a genetical factor involved predisposing the carrier to long-term development.

Pupal Mortality Studies, 1942–43 Season.—These results of work carried out under the writer's supervision could not be reported last season as they were incomplete. They are a continuation of the studies instituted in 1941–42, the methods used being fully described in last year's report. The main results are shown below, the figures for 1941–42 being reproduced to show the close agreement between the two years.

TABLE I.

PERCENTAGE MORTALITY AMONGST LARVÆ WHILST PUPATING.

		1941/42.	1942/43.
Before forming cell :	Larvæ eaten	17·1	14·5
	Larvæ dead	6·4	3·9
After forming cell :	Larvæ or pupæ eaten	4·5	8·5
	Larvæ dead	3·6	4·3
Successfully pupated		68·4	68·8

The distribution of fates in the two years is very similar and the net survival agrees extraordinarily well.

TABLE II.

PERCENTAGE MORTALITY AMONGST PUPÆ.

	Pupæ examined weekly (B)		*Pupæ examined at long intervals (C)*	
	1941/42.	1942/43.	1941/42.	1942/43.
Missing or removed by predators, or accidentally	4·9	8·4	12·4	7·5
Eaten by predators	20·7	40·7	20·9	41·6
Dried up or moulded	29·9	12·5	15·3	4·3
Successfully emerged	44·5	38·4	51·4	46·6

The main difference between the two years is the much greater loss due to predators in 1942–43, and a smaller loss from desiccation and mould. The net survival, however, is very much the same in the two years, being, from the time at which the 5th instar larva is fully fed to the emergence of the moth, 35·2% in 1941–42 and 31·1% in 1942–43.

The variation in the cause of loss amongst pupæ may perhaps be explained by the field conditions in the two years : the 1941–42 season was exceedingly dry and the crop was poor, giving little cover and not carrying a large bollworm population. This would tend to increase losses due to desiccation and to diminish those due to predators—indirectly, through offering little cover to the predator population and directly, by diminishing their food supply and hence their numbers. In 1942–43, on the other hand, conditions, though still dry, were a good deal less severe than in the previous year, and the crop and cover were very much better.

The other conclusions reached in 1941–42 were all confirmed.

Stainer Breeding Work.—This work is now being concluded, after just over two years' continuous recording, but full results have not yet been worked out. Results on the mortality amongst eggs and 1st instar nymphs exposed to various climatic conditions confirm those reached the previous year, the development of eggs depending mainly on temperature and ceasing when this rose above 34·5°C. and the development of 1st instar nymphs depending mainly on humidity.

It has, however, been now shown that in the most favourable situation occurring naturally, viz., in soil debris in a dense thicket surrounding the base of one of the main hosts, *Sterculia appendiculata* K.Sch., eggs can hatch and the 1st instars so derived can moult right through the hot dry season (September to December), at a time when breeding in less protected sites is completely inhibited.

Over the period August, 1941, to April, 1943, the subsequent survival of the later nymphal stages under insectary conditions, *i.e.*, atmospheric conditions in a shaded hut, freely ventilated, with water and cotton seed provided, is as follows :—

TABLE III.

SURVIVAL IN DIFFERENT INSTARS OF *Dsydercus* Spp., MEANS OF MONTHLY MEAN VALUES, EXPRESSED AS % SURVIVAL IN EACH INSTAR.

	II.	*III.*	*IV.*	*V.*	*II–V.*	*No. of individual records.*
D. fasciatus Sign.	72·6	87·5	88·5	82·9	46·6	2,759
D. intermedius Dist.	68·2	85·5	89·9	84·2	44·1	3,238

The results from the two species agree pretty closely : even under the most favourable possible conditions for survival, less than 50% of individuals manage to survive the nymphal stage. Combining the above results with those for eggs and 1st instar nymphs, the latter being based on the mean of two years' records (July, 1941–June, 1943, inclusive) at 100% R.H. at insectary shade temperatures, we have the results below.

TABLE IV.

SURVIVAL FROM EGG TO ADULT IN *Dysdercus* Spp.

	No. of Eggs Used.	*Mean Percentage Survival in each Stage.*			*Net % Survival Egg–Adult.*
		Egg.	*Instar I.*	*Instars II–V.*	
D. fasciatus	21,789	26·2	54·8	46·6	6·7
D. intermedius	22,962	26·8	59·7	44·1	7·1

Again the results for the two species tally closely and show that even under favourable conditions, with predators excluded, the net survival from egg to adult only averages 7% over the whole year. As the number of eggs laid per female (records from September, 1941–March, 1943, inclusive) is approximately 70, then over the whole year each female on the average produces 5 adults. These figures are means based on records extending over many months. The seasonal variation is, of course, considerable, as is shown by the figures for highest and lowest monthly values of survival in different stages.

TABLE V.

MAXIMUM AND MINIMUM MONTHLY SURVIVALS IN DIFFERENT STAGES OF *Dysdercus* Spp. (the two highest or lowest months are noted, with the value of the percentage survival in brackets below).

	Eggs.		*Instar I.*		*Instars II–V.*		*Net Survival.*	
	Highest.	*Lowest.*	*Highest.*	*Lowest.*	*Highest.*	*Lowest.*	*Highest.*	*Lowest.*
D. fasciatus	Mar. (45·7) Jan. (43·4)	Oct. (1·0) Sept. (2·0)	Mar. (84·3) April. (73·7)	Oct. (Nil) Nov. (10·2)	May. (65·0) Feb. (56·2)	June. (31·0) Sept. (31·6)	Mar. (18·9) May. (18·0)	Oct. (Nil) Sept. (0·1)
D. intermedius	Jan. (44·6) Feb. (42·7)	Nov. (0·5) Oct (3·0)	Dec. (82·5) Feb. (79·5)	Nov. (Nil) Sept. (38·0)	Feb. (61·0) May (60·5)	June. (27·6) Sept. (26·6)	Feb. (20·7) May (18·3)	Nov. (Nil) Sept. (0·8)

These figures show that the most favourable conditions for development occur in the late rains and the early dry season, the least favourable in the late dry season.

Rate of development is most rapid in February (Instar II–V, 21·9 days in *D. fasciatus*, 23·6 days in *D. intermedius*) and slowest in June (comparable figures 48·0 and 47·1 days).

Stainer Wild Host Records.—Records have been in progress from the start of the year on the flowering, fruiting and stainer populations of the main host trees at a number of points on the Lower River. These comprise the baobab, *Adansonia digitata* L., and three species of *Sterculia*, *S. africana* (Lour.) Fiori, *S. appendiculata* K.Sch., and *S. quinqueloba* (Garcke) K.Sch. *Thespesia rogersii* S. Moore also occurs in the Lower River, but it is not common and is believed to be of small importance. Small numbers of the cultivated kapok, *Ceiba pentandra* Gaertn., occur and are a source of considerable breeding of *D. fasciatus* and the rare *Bombax stolzii* Ulbrich occurs in a few specialised situations at the upper end of the valley, but this is also not believed to be of importance.

Records are only available to the end of July at the time of writing; these show that both *D. fasciatus* and *D. intermedius* occur on all the hosts, but the former breeds primarily on the baobab, with peaks of breeding in March and May–June, and only to a small extent on the genus *Sterculia*. *D. intermedius*, on the other hand, is found in small numbers throughout the year on baobab, with a peak of breeding in January, and occurs on *Sterculia africana* and *S. appendiculata* most of the year, the peak infestations being in January and May–June. This species of stainer also occurs on *S. quinqueloba* when the latter fruits in late April, and has a big breeding peak in late May.

All these hosts tend to breed up stainer before cotton becomes available as food, though it seems probable that a generation intervenes on herbaceous hosts between this generation and that reaching the crop. The main breeding period, however, is during the cool, dry season and it is conceivable, especially in the case of *D. intermedius*, that at this time of year these hosts exercise an attraction on dispersal flights of stainers bred up in cotton and thus to some extent relieve the later crop. This fact, coupled with the reduced rate of breeding during the cool season, accounts for the noticeable drop in numbers in the crop at this time of year.

The Interpretation of Red Bollworm Moth Emergence Noted in the Field in Terms of the Results of Experimental Work.—The results obtained to date, although not yet sufficient to give a complete explanation of the behaviour of bollworm pupæ throughout the year, are sufficient to allow a reasonable hypothesis to be constructed.

The experimental demonstration that larvæ bred on green food and at temperatures within the developmental limits give rise to

short-term pupæ explains the almost exclusive production of such pupæ in the field in the months of January to March on the Lake Shore and the Lower River.

It has also been shown that short-term pupæ developing at the temperatures experienced in the field in May–July have their development greatly prolonged, and there is also a suggestion that a mild form of long-term development may be so induced : this clearly accounts for the phenomenon referred to as " overwintering " pupæ, which do not emerge until the August rise in temperature.

From May onwards, on the Lower River, and rather earlier on the Lake Shore where it is cooler, the proportion of larvæ giving rise to long-term pupæ rises steadily, for reasons which we have still to demonstrate experimentally. It has been shown that such pupæ, if their development is not impeded at all, will emerge over a prolonged period ranging from about 3 to 9 months after pupation, with a mode at about 5–6 months, according to temperatures. Long-term pupæ formed in May should therefore be emerging from August to the following February, with a maximum emergence about October–November. The same sort of thing would apply to each month's production, extending to September-formed pupæ, which would start to emerge in December and range over to the following June, with a peak about January.

The development of such pupæ, however, is impeded—the months of September–November, or even December, if rains are late, giving soil temperatures which pass the critical limits shown by experiment to inhibit development. A retardation of 2–3 months would be expected in this way. But here again, only those pupæ which have passed through the quiescent phase of their life before the onset of the hot dry season will be so affected, since it has been shown that pupæ subjected to high temperatures during their quiescent phase do not suffer any lengthening of their pupal period. Assuming that the quiescent phase lasts about three months, then pupæ from May and June will have passed through this phase by the time the hot season starts and will therefore be fully inhibited by the high temperatures, their peak emergences being delayed until January–February and February–March respectively.

Pupæ formed in succeeding months will pass progressively less of their quiescent phase before the hot weather and their emergence will be delayed correspondingly less ; those formed in September, in fact, will pass the whole of this phase within the hot season and will thus escape inhibition altogether, their peak of emergence coming about January–February.

Thus, taking into account pupæ from all sources, the annual moth flight curve on the Lower River will tend to be high during May and June, due mainly to the emergence of short-term pupæ of the first generation bred in the field, and then will fall off on account of cold weather slowing down the rate of emergence and thus preventing

the accumulation of a large population. In August there will be a rise, due to the resumption of emergence from short-term pupæ, plus the earliest emergences from the long-term pupæ from May and June, followed, in the hot dry season, by a complete close down apart from the fraction of the short-term pupæ possessing a high threshold of temperature inhibition.

With the end of the hot dry season and lowered soil temperatures at the break of the rains will come a recommencement of emergences, consisting of heat-retarded pupæ from May–June, fortified firstly by July–August pupæ which have been less retarded and secondly by long-term September and October pupæ which have not been retarded by heat at all. All these pupæ will tend to emerge about the same time, but on account of the high degree of variation within each pupal population, the integrated curve of emergences will be a frequency distribution extending from December to June, with a peak about January–February.

Here, however, a further complication is encountered, namely, the effect of waterlogging on the long-term pupa. As has been demonstrated by Mitchell (*E.C.G.C. Repts. from Expt. Stations, 1940–41*, 169), submergence of pupæ for periods up to a month (and possibly for longer), inhibits long-term development, so that pupæ so treated have their pupal period extended by the same amount as their period of submergence. The months of late December to mid-February are those of heaviest rainfall, when the ground is pretty well saturated and, as Mitchell points out, there is probably inhibition of pupal development at this time for the reasons given above. Thus, the rising curve of moth emergence will be interrupted during these months and will become bi-modal, the first, and smaller peak being in December, and the second, and larger one, being shifted on to February–March.

This hypothesis is, of course, extremely generalised, and the emergence curve will be modified by all manner of factors, such as the pupal population formed each month, the incidence of mortality and the deviation of the weather from the normal. A very prolonged dry season, with intermittent and delayed rains, will imply high soil temperatures and thus emergence will be abnormally retarded. This occurred at Chikwawa in 1941 and 1942. On the other hand, prolonged and excessive rain will have the same effect : this was the case in the present year. In all three seasons the peak of the long-term emergence was delayed until April.

Application to Possible Control Measures.—Any control measures must be directed to :—

(i) Permitting the minimum carry-over of pupæ from one season to the next.

(ii) Failing that, preventing the survival of the larvæ derived from such pupæ as succeed in carrying-over, by providing a minimum food supply.

(iii) Failing that, adjusting the fruiting period of the crop to obtain the maximum ratio of fruit production to larval population.

Taking objective (ii) to begin with: this can be attained by planting the crop later in the year, so that there is no food supply for larvæ derived from carry-over pupæ. In years when the emergence is retarded for any reason this is virtually impossible with rain-grown cotton, and even in normal years the bi-modal nature of the emergence curve greatly decreases the value of the measure, since the bulk of the main emergence can only be evaded by delaying planting until February. The invariable practice on the Lower River of inter-planting cotton in cereal crops assists this aim, in that the food crop retards fruiting to a considerable extent.

Objective (i) may be attained by limiting fruit production, and hence larval production, to that time of year when only short-term pupæ will be produced, so that no carry-over from one season to the next is possible. This means in the case of rain-grown cotton that the main fruiting period must not be later than March–April, *i.e.*, planting must not be later than the beginning of January. The North Nyasa crop, planted on flood land after the water has receded, and maturing its crop exclusively in the hot season, appears to utilise this method with some success.

It should be remarked that flood land provides another explanation of its own freedom from bollworm, *viz.*, the lethal effect of submergence upon pupæ which have started to develop.

A certain proportion of long-term pupæ are, however, always formed in May and it is impossible to avoid this in rain-grown cotton, however early after the break of the rains this may be planted. The question arises, can anything be done to diminish the numbers of these, once they have been formed? Since the developmental period of such pupæ is determined in the larval stage, it appears impossible to "break their diapause"; the only possible measures are those directed (*a*) to destroying them, either by exposure to lethal temperatures or by encouraging the action of predators, or (*b*) to stimulating their earliest possible emergence by preventing the high temperature inhibition which occurs in the hot dry season.

Exposure to lethal temperatures, however, such as might be attained by keeping the soil as bare as possible in the hot dry season, as is the case on the Lower River at present, may defeat its object unless the temperatures are really high, since slightly lower ones will only succeed in stopping development without causing death. There is, however, some possibility, which is at present being tested, that early cultivation may assist predators and thus cause increased mortality.

The prevention of high temperature inhibition might be accomplished by early cultivation, to establish a protective mulch of

broken soil; or by the encouragement of weed growth in the later stages of the cotton crop, or by the actual application of a mulch, using cotton stalks and the remnants of the food crop from the cotton garden and from any adjacent pure stand food crop gardens, assisted by grass or any available trash, and only removing this at the last possible moment before the rains. An experiment to test these points is now going on and it has already shown that an enormous reduction in temperature can be obtained by these methods. It remains to be seen whether they will indeed have the desired effect of inducing May- and June-formed pupæ to emerge, as they should do, in or before November–December. It is worth noting that in South Africa, where the rains break earlier than in Nyasaland, and where the hot dry season is not nearly so severe, emergence of long-term red bollworm pupæ is usually complete by December.

Objective (iii) is that achieved, to some extent, in areas of pure stand, early-planted, rain-grown cotton such as the present Lake Shore area. The plant makes rapid early growth and succeeds in setting a large part of its crop before the bollworm has a chance of building up a really crushing population. The plant enters a senescent phase in May and there is thus only limited pupal production during the months of June–October, and therefore a correspondingly limited production of long-term pupæ. To be successful on land which tends to maintain a high moisture content right through the cool season, or in areas where there may be cool-season rains, this system requires the date of uprooting to be set as early as possible, lest a second flush of fruiting occur with rising temperatures and produce a further population of pupæ which will mainly be long-term.

There is thus a fairly wide choice of possible control measures and the question of which to adopt depends on which one will fit in best with the economic and agricultural development of the African grower.

Lower River Area (B. L. Mitchell).

General.

At the close of the 1942 season the writer was transferred from Salima to Limbe to take over the routine recording work of the Lower River from Mr. Pearson. Records were maintained at all stations as in previous years.

Weather Conditions.—On the Lower River the rains were somewhat late in breaking and only at Port Herald was any planting done in November. Once the main rains commenced, on about December 21st, the rainfall was very steady throughout the season and there was never a gap of more than a few days when planting was not possible.

Up to the end of April from 34 to 46 inches of rain had fallen at various points in the Lower River. During the cool season small showers have been recorded every month, but never in sufficient weight to affect the crop.

General Crop Notes.—Once the main rains had broken, conditions of ample moisture and ample sunshine held through January until mid-February. In all crops stands and growth were everywhere good. In the second half of February and during March there was a period of continuous rain which did a certain amount of damage in low-lying areas. Conditions held excellent for maize throughout the season and very high yields were obtained to an extent that some of it was not reaped until July. Bulrush millets suffered, rather badly round Chiromo, from smut, but soghum did very well.

Crop Statistics.—Port Herald was the only district where November plantings were possible, between 23% and 45% of the millet gardens and 15% of the maize gardens being planted in this month. At all stations the last of the millet and the maize was planted by the end of the first week in January.

Cotton.

No gardens whatsoever were planted in December. In the central part of the Lower River cotton planting was spread over all January and early February ; at the Chikwawa end there was a little planted in mid-January but the main planting fell in late January to February ; at Port Herald almost the whole crop was February planted. Subsequently the season was very bad indeed. During the second half of February, only eight weeks from the break of rains, the crop was subjected to the most severe jassid attack that has been witnessed by Mr. Pearson or myself. The attack was most severe on growing leaves, which were discoloured, wrinkled and stunted. Much of the crop was in the seedling stage and bore no fully-formed leaves at the time. The appearance of these fields was very bad indeed. It was remarked that pure stand cotton suffered much more severely than intercropped cotton. The fields looked in such bad condition that in several instances African growers actually uprooted their cotton and replanted it. This is without observed precedent.

By mid-April the jassid attack had slackened off, most of the damaged foliage had been shed and the younger growth bore little evidence of the severity of the onslaught. Cotton planted in February, especially where interplanted, was hardly attacked at all and yet even so was unable to overtake in growth jassid-damaged plants which were only two weeks older. Had the attack been sustained for a longer time it must inevitably have caused considerable damage, but it is believed that in fact very little direct harm was done. However, since then the Red bollworm attack has been so completely devastating that it has not been possible to form a sound judgment on the point.

Bollworm attack was very severe indeed and denuded the plants of fruit until late in the season. This resulted in continuous bud formation throughout the latter part of the cool weather and the dry season, and the plants finally managed to achieve some sort of a crop. The attack was most severe in the Chiromo and Port Herald areas and in these districts the crop ripened in September and October. The attack was considerably less severe in the Chikwawa district where the crop began to ripen in July. In N.A. Ngabu's area, however, where unfortunately on account of difficulty of access in the rains no records are taken, a good crop was set before the cool season. This commonly occurs in this area. It is believed that the explanation is that here the cotton was planted early whilst emergence of carry-over moths was similar to that experienced at Chikwawa (*q.v.*). A crop was thus set before the main emergence of moths took place.

Crop Production and Crop Loss.—This has been studied as in previous years by taggings and weekly garden samples, but owing to the late season the records have not yet been worked out. Suffice it to say that, except in Ngabu's area, no pre-cool-season crop was set owing to bollworm damage and the cool season crop suffered from stainer. The date of picking of the first clean locks on the plant samples at the various recording stations reflects the severity of the insect attack ; at Chikwawa this was mid-July, in the central part of the Lower River it was during August, and at Port Herald there was none until September.

Bollworm Activity.—The fear expressed in last year's report that a heavy infestation due to pupæ carried over from 1942 would be experienced this season was unfortunately fully justified. The egg-laying due to moths of the diapause flight was very heavy and sustained and, coming somewhat later than usual, coincided with the attempted fruiting of a rather late-planted crop. As was to be expected from the pupation figures, Chikwawa suffered less than the other stations ; nevertheless, all the pre-cool-season crop was taken. Port Herald produced the smallest total bollworm population, but the crop was just as completely destroyed as elsewhere, since in this district agricultural conditions are such that the plant's potential crop, as measured by the number of fruiting points produced, is only about half that of plants growing north of Chiromo. In the latter area the bollworm infestation was greatest, weekly mean egglaying per acre rising to between 29,000 and 37,000 eggs.

Stainer Activity.—Unlike the 1942 season stainer immigration commenced whilst heavy bollworm attack was still in progress and the plants did not get a chance of making a crop between the two attacks. The initial infestations started at the usual time but were heavier and went on longer, especially in the central area. Owing, however, to loss of bolls to bollworm, breeding was restricted by lack of mature food. At Port Herald there was virtually no breeding at all. In the central area *D. fasciatus* bred up in August and September, after the *D. intermedius* population declined.

Pupation Work, Red Bollworm.—Records were continued at all stations, using the same technique as in the past, and similar moth flight curves were constructed.

TABLE I.

CALCULATED NUMBERS OF MOTHS OF THE DIAPAUSE FLIGHT EMERGING PER ACRE AT DIFFERENT STATIONS, LOWER RIVER, 1942–43.

Month of Origin of Pupæ.	*Month of Emergence of Moths, 1942–43.*								
	Nov.	*Dec.*	*Jan.,'43.*	*Feb.*	*Mar.*	*April.*	*May.*	*June.*	*Total.*
CHIKWAWA.									
April	—	—	—	—	—	—	—	—	0
May	—	—	—	—	60	234	9	—	303
June	—	—	—	—	9	111	3	—	123
July	—	—	—	—	23	59	—	—	82
August	Material destroyed, no records								
September	—	1	4	2	17	30	—	—	54
Total	—	1	4	2	109	434	12	—	562
PORT HERALD.									
April	—	—	—	—	—	—	—	—	0
May	198	101	44	59	92	360	18	—	872
June	325	339	95	101	143	386	61	—	1,450
July	5	7	—	2	1	7	6	—	28
August	47	43	9	10	9	70	19	—	207
September	68	37	15	30	5	71	57	—	283
October	1	—	1	—	—	4	2	—	8
Total	644	527	164	202	250	898	163	—	2,848
CHIROMO-MLOLO.									
April	11	—	3	—	82	115	41	—	252
May	392	—	57	170	924	974	69	—	2,586
June	53	6	—	93	254	584	25	11	1,026
July	9	—	1	3	6	68	3	1	91
August	2	—	2	2	18	64	1	1	90
September	20	5	33	22	25	43	3	6	157
Total	487	11	96	290	1,309	1,848	142	19	4,202

. Chiromo-Mlolo and Port Herald therefore show the usual bi-modal curve of emergence, whilst Chikwawa has a curve with only one peak.

TABLE II.

PROPORTIONS OF THE DIAPAUSE FLIGHT WHICH WOULD HAVE BEEN EVADED BY COTTON PLANTED AT DIFFERENT DATES.

(based on the fact that food is available for larvæ 6 weeks after planting).

Date of Planting.	*Date Food Available.*	*Percentage of Total Diapause Flight Evaded.*		
		Chiromo-Mlolo.	*Chikwawa.*	*Port Herald.*
19 Dec., 1942	30 Jan. 1943	2·9	0·9	31·3
26 ,, ,,	6 ,, ,,	4·3	1·0	31·3
2 Jan., 1943	13 Feb. ,,	5·7	1·0	35·0
16 ,, ,,	27 ,, ,,	10·7	1·2	40·4
30 ,, ,,	13 Mar. ,,	21·6	6·3	40·7
6 Feb., ,,	20 ,, ,,	30·5	12·6	43·6
13 ,, ,,	27 ,, ,,	45·9	23·7	51·8
27 ,, ,,	10 April, ,,	81·2	74·0	68·6

This table does not take into account November emergence since there is not and could not be cotton in the ground in that month, and those moths are destined to die in any circumstances without being able to lay eggs on cotton.

From the practical point of view the moth emergence is similar to that of 1941–42, with the two types more exaggerated. At Chikwawa this year there was an opportunity to get the cotton planted and a crop set before bollworm put in its appearance in any strength. At Port Herald, on the other hand, a very considerable proportion of the

diapause flight could have been, and in fact was, evaded by delaying planting into February. At Chiromo the emergence tended more to the Chikwawa pattern than it did last year.

The expected carry-over of pupæ from this year is even greater than that from last year, so that the outlook for the coming season is not promising.

Effects of Digging on Pupal Mortality.—The experiment carried out at Salima in 1942 was not finished at the time of writing the report and so requires mention here. In this experiment randomised blocks were laid out at the time of cotton uprooting in July, with two treatments, one of which was left with a bare, undug surface and the other given a normal digging. They were sampled for bollworm pupæ in July and again in late October, to ascertain whether predator activity is facilitated in dug soil. Owing to November rains the late sampling was rendered exceedingly difficult and the expected complement of pupæ was not obtained. For the second season running the undug plots were found to contain 50% more pupæ than the dug ones. However, numbers were still disappointingly small. The experiment is being repeated this year on a larger scale and results should be conclusive. It has been shown that a field sampled immediately after digging does not contain significantly fewer live pupæ than before digging.

Pupal Mortality Under Field Conditions.—This experiment was carried out this season on the same lines as those used in 1941–42, the results of which are also given in Table III. Two cotton fields were used on the Cotton Station, Salima, separated by about one mile. One field was cultivated in normal routine station manner whilst the other was allowed to grow a crop of weeds to imitate conditions existing in the ordinary African garden. The results in the two fields are not, of course, statistically comparable. Treatment B was examined weekly throughout the experiment, whilst Treatment A had its first examination at the time of cotton uprooting in July, and was later overhauled in November, January and March.

TABLE III.

FATES SUFFERED BY RED BOLLWORM PUPÆ WHEN EXPOSED UNDER NATURAL CONDITIONS.

	1941–42.		1942–43.			
	Clean Field.		*Clean Field.*		*Weedy Field.*	
	A.	*B.*	*A.*	*B.*	*A.*	*B.*
No. of pupæ used	535	535	600	600	600	600
Percentage eaten by predators	82·6	73·4	83·2	81·4	70·2	71·7
Percentage total emergence	14·2	20·2	11·2	8·8	21·9	11·0
Percentage dried or moulded	3·2	6·5	4·0	9·3	6·5	16·4
Percentage accidentally damaged ...	—	—	1·8	0·5	0·8	1·0
Percentage effective survival to new crop	7·1	4·9	21·5	20·0	6·6	5·3
Actual No. of survivors to new crop ...	30	21	30	15	42	24

In both fields the predators were the same as in the previous year and consisted of small rodents, tenebrionid larvæ and ants. In the clean field most of the rodent depredations took place before July, whilst in the weedy field rat activity continued until the break

of the rains. In 1941, however, rats did not seriously make their presence felt until after the cotton had been uprooted.

In the Table above, by effective survival to the new crop is meant the number of pupæ surviving to the new crop expressed as a percentage of live pupæ existing in the field at the time of uprooting the old crop. In Treatment A the figure is taken as the number emerging after the November overhaul, whilst in Treatment B it is based on weekly observations. The former figure is therefore slightly high and may be regarded as a maximum value.

In the clean field, the heavy rodent damage from April to July and the subsequent freedom from these animals is reflected in the high total mortality combined with a relatively high percentage of the survivors to emerge. In the weedy field, although there was a somewhat lower total mortality, the dry season mortality is high on account of the continued presence of rats at that time. The experiment is being repeated this year.

Moth Migration.—The experiment to ascertain the maximum distance which Red bollworm moths are capable of flying was carried out as described in last year's Report. Recovery of marked moths was very small indeed and no moths were recaptured other than those liberated at the trap site. The value of such results as were obtained has not yet been fully assessed.

Development in Entire and Naked Pupæ.—It was stated in last year's Report (p. 160) that the behaviour of naked pupæ is identical with that of pupæ within their cocoons when both are kept under constant conditions. This statement was based on the earlier and smaller of two experiments and the results were heavily weighted with short-term pupæ. When analysed by weeks by the χ^2 test, the results were uniform, but when re-arranged and analysed by months a difference was apparent. However, since analysis by weeks allowed a larger degree of freedom than analysis by months, the writer maintained the greater accuracy of the former method. In the second experiment, commenced in June, 1942, the results now available show that the difference between the two groups of pupæ is not flattened out, when incubated under constant temperature conditions, when predominantly long-term pupæ are used. This has been confirmed by Mr. Pearson.

Larval Nutrition Experiments.—The object of these experiments is to ascertain whether the nature of the larval food can influence the duration of pupal life and more particularly, to find out whether any particular food is responsible for the initiation of long-term pupal development. This problem has previously been tackled for two years as an insectary experiment at Salima, but has failed owing to the difficulty of rearing larvæ under these conditions, believed to be due to the large amount of moisture condensed in the breeding tubes under the insectary conditions of widely fluctuating temperatures. The diurnal range was sometimes 15°C.

It was therefore decided to use natural wild field-fed larvæ for an experiment which was carried out both on the Cotton Station at Salima and the Sub-Station at Chiromo. A uniform acre of cotton was divided into 6 equal plots and these were so treated that they carried no buds, flowers or bolls of any sort other than those formed from the bud-setting of one particular week. The different plots were allowed to set fruit at fortnightly intervals, all remaining buds being stripped. Thus when the last plot had come into bearing a series of plots was available of which each one carried food of a definite age and of no other age. The natural infestations in these plots was utilised as a source of material; any fully-fed larva collected in any plot would necessary have completed its entire life on food of an age not greater than that of the food on the plot at the date of collection and not differing from this by more than the length of the larval life. Full-fed larvæ were collected in each plot twice weekly, pupated locally under insectary conditions and then despatched for incubation at 30–31°C. in Limbe or Zomba. From Salima satisfactory numbers of pupæ were obtained, but at Chiromo the tremendous weight of the bollworm attack, added to the artificial stripping of buds, resulted in a virtual wipe out of all fruiting points and hence very small numbers of larvæ.

Emergence from the Salima material is not yet complete but there is no suggestion that any major differences will show up. No food, not even small buds, has produced exclusively short-term pupæ and, indeed, some bud-fed material is already 23 weeks old. The different treatments are running very uniformly. It therefore appears that the age of larval food is not likely to be the deciding factor in the production of long-term pupæ. Confirmation of this point by further laboratory work is being sought by Mr. Pearson at present.

PROGRAMME OF WORK FOR 1943-44.

By the end of the present season on the Lower River, *i.e.*, October 1943, we shall have maintained full-scale records for a length of time and over a variety of conditions sufficient for our purpose. Next season we propose to move over from full-scale to skeleton recording, whilst simultaneously carrying out experimental work on subsidiary control measures at the Chiromo sub-station. There still remains a considerable amount of experimental investigation of the factors which induce long-term pupal formation and there is a great quantity of pupal material at present undergoing treatment which will not complete its development until about June, 1944.

From November to May inclusive one of us, first Mr. Mitchell and then Mr. Pearson, will be on leave whilst the other will be in Zomba, finishing off the experimental work and supervising the skeleton

recording and field work on the Lower River. By the end of May we shall be in a position to concentrate on the task of writing up our results for publication. Such work will be for a two-fold purpose : technical papers for suitable journals, and a report in less technical form for local circulation, in which purely local, non-entomological factors can be considered, together with recommendations for control measures. This work will fully occupy us until the end of 1944.

The programme of work is thus as follows :—

1. Maintenance of skeleton recording work on insect pest populations and crop development and loss in the field.
2. Field pupation records.
3. Further moth flight experiments in connection with the use of mass rotation as a control measure.
4. Investigations of the effect of cultivation and mulching on the carry-over of pupæ.
5. Combined time-of-planting and spacing experiment with maize and cotton in relation to early crop production and efficient land utilisation.
6. Continuance of records of stainers on wild hosts, if this seems desirable after reviewing the first year's work in January, 1944.
7. Larval breeding at controlled temperatures, using food material from irrigated ratoon, in November–December, and plant cotton, in January–February.
8. Completion of experiments planned or in progress on pupæ in relation to the length and nature of long-term development.

[*Included by courtesy of the Nigerian Government.*]

NIGERIA.

INTRODUCTORY NOTE ON THE OBJECTS OF COTTON EXPERIMENTS AND THE MAJOR PROBLEMS OF COTTON GROWING

BY

THE DIRECTOR OF AGRICULTURE.

Northern Nigeria.

Our object is to increase the monetary return per acre, for the peasant farmer who grows cotton, without losing the " ready market " now obtained for Nigerian cotton. In other words, to improve yields without losing quality and the excellent reputation of Nigerian cotton on the home market.

Various introductions have been made with a view to achieving this ; but so far none has proved superior to our selected strain of Allen.

Owing to the war all experimental work is temporarily in abeyance, and cotton work is restricted to the maintenance of existing strains of Allen, and the issue of seed to farming areas with a view to flooding the Zaria cotton belt with the improved strains and subsequently extending to the rest of the main cotton belt. A mixture of strains has been evolved which satisfies the varying conditions of soil and climate of the main Northern Provinces cotton belt. Strains must be resistant to jassid, leafcurl, Blackarm and stainer.

Samples of strains are sent to the Shirley Institute annually to ensure that quality is maintained.

To summarise : work has been concentrated on efforts to increase yield without deterioration in quality ; this has been achieved by multiplication of improved strains of Allen. Increase in yield is also dependent on improvement of soil fertility, earlier planting, and closer spacing. The last has been achieved, but owing to the peasants' pre-occupation with food crops, it is very difficult to get them to plant their cotton sufficiently early to give optimum yields.

Southern Nigeria.

Ishan A (according to Dr. Harland a variety of *G. barbadense*) is the cotton now mainly grown for export in the important cotton-growing districts of Southern Nigeria. This cotton is in most respects very satisfactory, except for its roughness of lint. Extensive trials were made of introduced cottons of *G. hirsutum* and Sea Island

which are of finer lint than Ishan, and with crosses between them and Ishan, but these failed in agricultural behaviour. It appears that rought lint is closely linked with leaf hairiness, essential for jassid resistance.

In the absence of a better variety, attention is at present concentrated on the maintenance of the purity and increased yield of improved Ishan A by annual re-selection on lines recommended by Mr. J. B. Hutchinson.

As a check on the quality of the present Ishan A, samples of the 1941–42 crops were sent to the Shirley Institute for spinning tests, and the reports on them indicated that the cotton was up to previous standard. The insect pest, *Helopeltis bergrothi*, is at present very troublesome to cotton, and so far has only been controlled to a limited extent by hand-picking.

To improve the otherwise satisfactory qualities of Ishan A by introducing a strain with a smoother lint will require a very extensive breeding programme, and this development must be postponed until after the war.

PROGRESS REPORT ON WORK ON COTTON IN THE NORTHERN PROVINCES FOR THE SEASON 1942-43

BY

J. K. MAYO.

Introduction.

Routine work on the maintenance of the three best strains and their derivatives was continued, with multiplications of mixtures of these at Daudawa and on the Bauchi line.

Meteorology.

Rainfall at planting and for the first few months afterwards was well below average, but in the crucial month of October, 2·17 inches fell as opposed to an average of 1·6 inches. Yield was considerably above average.

Breeding.

As in 1941–42, mass selection in the ordinary crop was carried on as well as the maintenance of the three best strains.

PROGRAMME FOR THE SEASON 1943-44.

Maintenance and multiplication as in 1942–43. No trials.

PROGRESS REPORT ON WORK ON COTTON IN THE SOUTHERN PROVINCES FOR THE SEASON 1942-43

BY

O. J. VOELCKER.

Introduction.

Work on cotton for the year 1942–43 followed the programme of work submitted for the year in my last report.

Meteorology.

After two weeks of good rain at the beginning of the planting season there was a break of seven weeks during which no appreciable rain fell, the rainfall for July and August being 2·07 inches and 0·665 inch respectively, as against 4·92 inches and 2·88 inches of the previous five-year average. Although in September there was a good rainfall of 10·625 inches, the cotton plants never fully recovered from the effects of the check in growth they received in July and August. The rainfall for the four critical months of growth, namely, July–October, was 17·34 inches. This shows a short fall of about 3 inches compared with the previous five-year average.

Genetics and Breeding.

Eight bulk-selected strains of Ishan A from the previous year's selection plot were tested for yield in a Latin Square lay out. Although germination and early growth were excellent, drought and severe *Helopeltis* attack later ruined the crop and final yields were extremely poor, and no significant yield differences could be detected.

Of the 19 strains of local cottons specially selected for rough lint and grown during the season, fourteen were eliminated on account of insufficiently hairy leaves. The remaining five were examined for halo length and ginning percentage, and were found to be inferior to Ishan A, though two closely approach it. These five tested strains will be grown next season in a yield trial.

Entomology.

An infestation of *Helopeltis* was again experienced, but the extent of damage done was reduced by daily hand-picking the pest.

Summary and Conclusion.

The yield trial experiment on Ishan A failed owing largely to drought and *Helopeltis* attack. Apart from *Helopeltis* damage, it was thought that we might be reaching a stage where loss of vigour might be due to 14 years' continuous self-fertilization. To test this both selfed and open pollinated seeds have been obtained from selected plants, and these two types will be tried out during the 1943–44 season.

Five of the 19 strains of local cottons specially selected for rough lint were selected for further trial, the remainder having been eliminated on account of insufficiently hairy leaves, which makes them susceptible to jassid attack.

PROGRAMME OF WORK FOR THE SEASON 1943-44.

Establishment of yield trial (Latin Square) of 4 selected bulk strains (2 self-fertilized and 2 open pollinated) of Ishan A.

Establishment of yield trial (Latin Square) of 5 selected local rough-linted cottons.

Satisfactory strains to be sent to the Shirley Institute for lint tests.

WEST INDIES.

COTTON RESEARCH STATION, TRINIDAD. GENETICS DEPARTMENT.

PROGRESS REPORT FOR THE PERIOD OCTOBER, 1942—SEPTEMBER, 1943

BY

J. B. HUTCHINSON AND S. G. STEPHENS.

Introduction.

By contrast with the previous year, the 1942–3 season was very unfavourable for cotton. Rain and humid conditions persisted throughout most of the cropping period, and damage by soft rots was severe especially in *G. barbadense* material. Pink bollworm also caused considerable damage, and *Sacadodes* (Trinidad bollworm) was common on the late crop. Stainers were never serious.

Genetic Research.

Anthracnose resistance.—The early attack of anthracnose recorded in the last report developed into a crippling epidemic on a batch of (Sea Island × U.4) × U.4 backcross material. Though disastrous to the main objects of the experiment, it made possible the selection of anthracnose-resistant material of predominantly U.4 character. It appears likely that resistance could be transferred from Sea Island to Upland cottons without difficulty.

Developmental Genetics.—This section of the work has so far been confined to the development of leaf shape, a character which has been extensively studied genetically, and which offers no great technical disadvantages to developmental analysis. It has been considered from three aspects, and since the results will shortly be published in full, a brief summary only will be necessary here.

It has been found, in the first place, that leaf shape development throughout the genus *Gossypium* is based on a common plan with surprisingly little modification. The various leaf shape alleles control, as parts of a single harmonious process, (1) relative growth rates in individual leaves, (2) rate of progressive change in leaf shape from node to node, (3) " timing " of leaf shape development relative to age of plant. Secondly, it has been found in attempting to identify alleles, that since each allele controls a developmental process rather than standardizes any particular " end effect," examination of leaf development forms a more accurate basis for identification than the recording of climax leaf indices. Thirdly, by using the developments

of standard alleles as analysers, it has been found possible to find out what other plant processes affect leaf shape and how they modify its expression. The results indicate that leaf shape modifiers are not subsidiary genes of minor importance, but, on the contrary, are genes controlling fundamental plant processes (time of flowering, rate of growth) which have considerable selective value on their own account.

The possibility of applying the same general principles to practical plant breeding problems, particularly to the problem of efficient selection for yield, is worth testing and a preliminary examination of contrasting Upland varieties is now in progress. Genetics *per se* have so far provided no useful information in this field. The reason is clear. Since yield is the resultant of a complex of co-ordinated physiological processes, the geneticist has no problem to tackle until the most important of these processes have been analysed, at least to the extent that they are capable of recognition. The leaf shape investigations have given a clear picture of how genes control growth and developmental rates, so that the static concept of adult leaf shape expressed as a leaf index can be converted into the dynamic concept of a developmental track. It is perhaps not idle to hope that yield per plant may, in a similar way, eventually be considered in terms of rates of growth and development.

Induced polyploidy.—Two new polyploids are under cytological investigation :—(1) An allotripioid (tetraploid *G. arboreum* × *G. anomalum*) (2n = 39). (2) An amphidiploid (*G. arboreum* × *G. anomalum*)$_2$ (2n = 52). The amphiploid crosses readily with New World cottons and with tetraploid *G. arboreum*. It is only weakly self-fertile, thus resembling tetraploid *G. arboreum*.

Hybrids have been obtained between the American diploid *G. raimondii* and a series of Asiatic types carrying different leaf shape alleles. An attempt is now being made to synthesize amphidiploids by colchicine treatment of these hybrids. If successful, the amphidiploids obtained should furnish an interesting comparison with New World cottons, and provide useful material for testing homologies between Asiatic and New World leaf shape alleles.

Morphology of Gossypium and related genera.—Within the limits of the rather meagre material available, the physiological and morphological similarities between *Gossypium* and neighbouring genera have been studied. It is known that both *Thespesia populnea* and *Thespesia garckiana* have gametic chromosome numbers of n = 13 as in the Old World and American diploid cottons. *Thespesia populnea* will graft easily with *Gossypium sturtii*, but with no other cotton. *Thespesia lampas* was obtained from Jamaica recently, and has been compared with *Gossypium* and other species of *Thespesia*. It is evidently widely separated from *T. populnea*, which is the type of the genus, and from *Gossypium*. Its sympodial fruiting branches, dry, brittle, widely opening capsule, and small, naked, turbinate seeds, are so distinct as to justify the establishment of a separate genus.

Nevertheless it grafts freely with *T. populnea*, and with *Gossypium sturtii*. Grafts with *T. garckiana* failed. Counts of first metaphase plates by one of us (S.G.S.) show that n = 13, as in the true *Thespesias* on which information is available.

The sympodial fruiting branch was formerly regarded as characteristic of *Gossypium*, but shortly after its discovery in *Thespesia lampas* it was noted by R. A. Silow on herbarium material of *Cienfugosia gerrardi* from Natal. In both true *Thespesia* and *Cienfugosia*, the flowers are usually borne either on jointed peduncles or on simple axillary pedicels. In *Gossypium*, the wild New World species can be arranged in a series showing progressive reduction of the fruiting branch from a many-jointed sympodium to a single-jointed sympodium, a jointed peduncle and finally a flowering spur. It is now evident that similar series are to be found also in related genera.

The seed hairs of *Gossypium* are of two kinds, unconvoluted and convoluted. In unconvoluted hairs secondary thickening proceeds until the lumen is practically obliterated. When the capsule opens the hairs dry without collapsing and no convolutions are formed. In convoluted hairs a considerable lumen remains when secondary thickening is complete. On drying, the hairs collapse on the central lumen, forming a flat ribbon which twists spirally to give the characteristic convolutions of cotton lint. Unconvoluted hairs remain matted flat against the surface of the seed, whereas convoluted hairs expand, forming a fluffy mass. The seed hairs of wild diploid species are unconvoluted. Those of the cultivated diploid species (Old World cottons) and of the tetraploid species (New World cultivated and Polynesian wild cottons) are convoluted. Recently, a mutant from MSI Sea Island cotton was received in which the seed hairs fail to expand. Examination showed that the hairs are fully thickened, and fail to collapse and twist. They are, in fact, very long but otherwise typical unconvoluted hairs. It appears, therefore, that the basic step in the development of spinnable lint was a reduction in the amount of secondary thickening, leaving sufficient lumen to allow the hair to collapse.

The convoluted hair character in cotton probably only arose once, since the Old World cottons are closely related and the tetraploid cottons all carry a set of 13 chromosomes homologous with the genom of the Old World cultivated species. There appears to be no reason why such a comparatively simple change as a reduction in thickening should not occur more than once, and in fact the seed hairs of *Gossypium brevilanatum* are typical convoluted hairs. Since recent work has shown that *G. brevilanatum* and *G. kirkii* are so far separated from the cottons as to justify the creation of an independent genus, it is scarcely possible that the lint of *G. brevilanatum* and of the cultivated cottons can have been derived from a common source.

These observations on the nature and distribution of lint hairs in *Gossypium* support Stephens' conclusions (*J. Genet.* **44**, 272) on the limitations to the use of induced allopolyploidy to increase the range of

material available for breeding improved cottons. Evidently, of the possible fertile allopolyploids, only those carrying a genom from a linted species are likely to be of interest to the plant breeder.

PAPERS SUBMITTED FOR PUBLICATION.

Hutchinson, J. B.	"The Classification of the Genus *Gossypium*."
	"A Note on *Gossypium brevilanatum*."
	"The Cottons of Jamaica."
Silow, R. A.	"The Inheritance of Lint Colour in Asiatic Cottons."
	"The Genetics of Species Development in the Old World Cottons."
Stephens, S. G.	"Grafting Experiments with Cotton."
	"The Genetic Organisation of Leaf Shape Development in *Gossypium*."

PROGRAMME.

There is no change to report in the experimental programme. Stocks of seed of the type collection will be accumulated in readiness for the transfer to Uganda when circumstances permit, and a few new experiments that will be of value at the new Station are being set up.

PHYSIOLOGICAL DEPARTMENT.

OUTLINE REPORT ON WORK DONE DURING 1942

BY

T. G. MASON and E. PHILLIS.

Work on foliar hydration has been continued. The disc and pruning techniques have both been used and another method is being examined. The mechanism whereby salts increase the water content of the cell is still far from clear. It has been observed that salts increase the water content of both protoplasm and vacuole. Respiration does not seem to be affected. There appear to be three main factors determining the relation between water and salt. There is first of all the condition of the protoplasm. In some plants the cell may accumulate large amounts of salt without any uptake of water. In cotton this completely inert condition has not yet been encountered. The most important factor in cotton is the amount of salt, but the rate at which salt is accumulated is also a factor. When the rate of accumulation is low the amount of water per unit of salt entering the cell is less than when it is high. A very interesting observation has been made on the after-effects of salt accumulation. It has been found that water continues to enter the cell for some days after salt accumulation has been stopped. We are at present exploring more fully the influence of different salts and mixtures of salts on hydration and protoplasmic synthesis.

We have also investigated the effects of the nutrient elements nitrogen, potassium and phosphorus on hydration in the growing plant. Potassium increases foliar hydration under humid conditions, due, we believe, to an increased salt content of the leaf. This effect may be obscured or even reversed under arid conditions, especially where potassium leads to well marked increases in the size of the plant. This is probably due to increasing water strain as the size of the plant increases. Nitrogen also increases hydration under wet conditions, due, we believe, not to increased salt, but to some change in protoplasm. This effect also can be obscured and apparently even reversed by arid conditions, but the reversal requires much more stringent conditions than is the case of potassium. The suggestion that nitrogen may increase water stability under dry conditions would account for the peculiar effectiveness of nitrogen fertilisers under desert conditions, as in the Punjab and the Sudan. The response to changes in phosphorus supply resembles that for nitrogen, but it is not so pronounced.

Last year we remarked that the plant's requirements for a particular element (by which we mean the level of concentration about the roots required for optimum dry weight production) might vary in response to climate. Nitrogen has been found to behave like phosphorus in that a higher concentration is required under dry sunny conditions than under moist shady conditions. Further work on potassium has shown that the optimum potassium level may not be independent of

climate as we suggested, but may actually be greater under moist than under dry conditions. This is in harmony with the known efficiency of potassium fertilisers in wet sunless summers in England.

Moreover, the response in dry weight production to changes in nutrient supply also appears to be affected by climate. Nitrogen, potassium and phosphorus all show a greater dry weight for a given change in nutrient supply (provided that the nutrient range is below the optimum) under dry, sunny than under dull and moist conditions. Nitrogen shows a much greater effect than potassium and phosphorus. This difference may be correlated with the observation that with nitrogen starvation, plants grown under dry conditions may be smaller than those grown with the same level of supply under wet conditions, whereas with potassium and phosphorus the sun plants are always bigger than the shade plants.

These results have been obtained with plants grown under greenhouse conditions in sand culture and are concerned only with the dry matter of the whole plant up to the time of flowering. If they can be extended to cover crop production under field conditions they would serve to emphasise the importance of considering climate in the planning of fertiliser trials.

We have continued our search for methods of diagnosing the nutrient status of the growing plant through analysis of its parts. We have found that excess nitrogen causes a marked depression in dry weight production and that the margin between the optimum level of supply and a deleterious effect is very narrow. The prospects of diagnosing nitrogen status are good, and for potassium fairly good, but so far no satisfactory method for diagnosing phosphorus status has been elaborated. Of course, translation of results obtained by these plant diagnosis methods into satisfactory practical recommendations will involve the use of climatic forecasts. There might be little point in correcting a mild nitrogen deficiency if wet weather was anticipated.

COTTON EXPERIMENT STATION, ST. VINCENT.

PROGRESS REPORT FOR THE SEASON 1942-43 AND PROGRAMME OF EXPERIMENTS FOR THE SEASON 1943-44

BY
H. L. MANNING.

Introduction.

Unsatisfactory rainfall distribution during the early part of the season resulted in poor and uneven growth. In addition, a severe attack of Pink bollworm reduced yields considerably. The consequent effect on the precision of the experiments is reflected in the high coefficients of variation of the replicated trials.

The total area under cotton in the island amounted to 3,534 acres, of which 2,078½ were peasant cultivation. The peasant yield per acre was 62 pounds of white lint and that of the estates 142 pounds. The island's yield of white lint gave an overall average of 95 pounds per acre.

The island's planting seed supply area was distributed over two estates. At one 55 acres produced 10,929 pounds of white lint and at the other 77 acres produced 14,777 pounds. An adequate seed supply is available for planting the 1943–44 crop.

Genetics and Breeding.

Superfine Breeding Trial.—Since the modern superfine V.135 contains no appreciable genetic variance and therefore offers little scope for further improvement, only the two main strains were included in a replicated trial with four promising Barbados Sea Island progenies, the American variety Seabrook, and the doubled haploid of Type 18, the original V.135. Statistical analyses of a blank experiment of a previous season indicated that ten replications of eight varieties in eight-plant plots were likely to enable detection of yield differences of the order of 20%. Since adjacent progeny rows were grown to provide data on characters which are subject to low environmental variance, and in which the variances of superfine and ordinary sea island cottons differ, only characters subject to relatively large environmental variance, such as yield and bolling, were subjected to the analysis of variance.

Early growth and flowering were essentially similar in the eight progenies and it was not until maturity that any marked differences were observed. It became apparent that under field conditions the shorter B.S.I. variety had considerably more bolls than the taller V.135 or Seabrook.

The analyses of variance show that B.S.I. significantly outyielded V.135, which in turn outyielded Seabrook. It is obvious that, besides being better bollers, the B.S.I. progenies have more lint per seed than V.135 and in the synthesis of yield this combination more than outweighs the slight superiority in seeds per boll of the latter strain. Although the genetic variance of Seabrook is comparatively high, its bolling was so poor that, in spite of the fact that it had the highest seeds per boll and lint per seed, the yield was disappointingly low.

The inclusion of the doubled haploid from Type 18—V.135—was primarily to obtain some information on the variability of a progeny that was theoretically completely homozygous. It was unfortunate that owing to seasonal effects the environmental variance was abnormally high and, although there was some evidence of reduction in variability, the data were inconclusive.

TABLE I.
SUMMARY OF SUPERFINE BREEDING TRIAL.

Variety.	*Number of Days 1st Flower.*	*Seed Cotton. gms.*	*Bolls per Plant.*	*Seeds per Boll.*	*Lint per Seed. mgm.*	*Lint per Plant gms.*	*Seed Weight. mgm.*	*Ginning Per-centage.*
B.S.I.	67·4	68·6	30·3	14·5	41·6	17·8	119	25·9
V.135	65·6	70·7	26·6	16·0	37·8	16·2	128	22·9
Type 18	67·8	50·9	28·4	11·9	35·4	11·9	117	23·4
Seabrook	67·3	49·6	15·3	17·4	45·2	12·2	140	24·6
C.V.%	4·9	—	29·5	14·5	5·6	25·0	—	—
F for Progenies ...	N S	—	V S.	V.S.	V.S.	V.S.	—	—

The VH Breeding Trial.—Forty-nine progenies were tested in a Balanced Incomplete Block trial with 56 blocks, each containing seven of the standard eight-plant plots. Adjacent were 49 progeny rows to provide selfed material and for observation on the characters subject to low environmental variance, such as lint length. The characters bolling, total seed cotton, total lint and certain others were analysed on the data from the replicated trial. In designing the trial, blocks were so arranged in the field that the experiment could be analysed as a Randomized Complete Block in addition—to assess the efficiency of the design.

TABLE II.
SUMMARY OF VH BREEDING TRIAL.

Variety.	*Plant Height. cms.*	*Seed Cotton. gms.*	*Bolls per Plant.*	*Seeds per Boll.*	*Lint per Seed. mgm.*	*Lint per Boll. gms.*	*Lint per Plant. gms.*	*Seed Weight. mgm.*	*Ginning Per-centage.*
VH.8 (3)	131·8	82·4	29·1	14·3	51·0	0·72	22·4	136·3	27·2
VH.9–11 (14)	125·2	65·3	23·9	12·7	56·7	0·71	18·7	141·5	28·6
VH.9– 5 (24)	124·8	63·0	23·3	12·7	53·9	0·70	17·8	140·9	28·3
VH.10 (8)	120·3	60·5	22·5	12·6	57·3	0·72	17·6	141·0	29·2
C.V.% ...	9·6	22·4	21·4	14·2	7·0	12·0	23·0	3·7	—
Efficiency ...	132%	158%	145%	97%	102%	105%	152%	120%	—
F for Strains	*	V.S.	V.S.	V.S.	V.S.	N.S.	V.S.	V.S.	—
F for Progns. within Strains N = 49	VH.10*	N.S.	N.S.	VH.8 * VH.9–5*	VH. 8* VH. 9–11* VH.10***	VH. 9–5* VH.10*	VH.10*	N.S.	—

The three fairly typical main strains, VH.8, 9, and 10, provided the material for the trial. The 49 progenies were made up of three VH.8's, thirty-eight VH.9's and eight VH.10's. Since the small-scale spinning

tests have shown much of the VH material to be within the V.135 range of variation, particular attention was paid to performance in the field and ultimate yield.

Reference to Table II shows that the precision of the experiment was good enough to detect yield differences of 24% (S.E. (diff.) 12% of G.M.). In view of the high Pink bollworm infestation this was considered to be very satisfactory. Comparison with a Randomized Block analysis showed that the Incomplete Block design had increased efficiency by about 50% in the more variable yield characters, bolling, seed cotton yield and lint yield. A 30% improvement in efficiency was recorded in plant height. In the characters with low variability, no appreciable increase in efficiency was obtained, except with seed weight.

Significant differences between groups were recorded for all characters except lint per boll and flowering. As the latter is considered to be of relatively small importance to yield it has not been included in the table. Ginning percentage was not subjected to an analysis of variance. Taking the basic yield synthesis as bolling × seeds per boll × lint per seed, the comparative stability of main strain groups is clearly shown in VH.8, VH.9 and VH.10. The VH.8 group is morphologically similar to V.135, the important difference being the higher lint per boll of the former. The VH.10, which is morphologically similar to the Montserrat parent, has the highest lint per boll of the VH's. The VH.9 groups, which combine the desirable characters of both VH.8 and VH.10, were to some extent disappointing.

Significant differences within groups were recorded for flowering, plant height, seeds per boll, lint per seed, total lint and lint per boll. The variability was highest in VH.10.

To determine the relative importance of the basic yield characters a multiple regression of lint yield on bolling (X_1) × seeds per boll (X_2) × lint per seed (X_3) was carried out. The regression equation and standard regressions show that the relative importance is in the same order.

$$E = 0{\cdot}5721\ X_1 \text{ (bolling)} + 0{\cdot}8072\ X_2 \text{ (seeds per boll)} + 0{\cdot}1553\ X_3 \text{ (lint per seed)} - 14{\cdot}27.$$

When Y = Lint Yield the standard regressions are :—
$\beta Y\ 1{\cdot}23 = 0{\cdot}6978$ (bolling) ; $\beta Y\ 2{\cdot}13 = 0{\cdot}4080$ (seeds per boll) ; $\beta Y\ 3{\cdot}12 = 0{\cdot}2241$ (lint per seed).

VH Small Bulks Trial.—The experimental scope of this trial was broadened to give data over a wide range of conditions. At the Experiment Station contour bench terraces, on a 45% slope with 5′ vertical intervals, were used to compare four VH's against the standard V.135. The nature of the terraces was such that unweathered subsoil provided the growth medium, and the subsequent growth was so poor as to preclude the possibility of accurate statistical analysis of the data. The general trend of yield showed, however, that the V.135 was inferior to VH.8, VH.9–5 and VH.10.

At another locality a similar trial in which climatic as well as cultural conditions simulated poor land, both VH.8 and VH.9 outyielded V.135. While the experimental error was too large to show significant differences, the VH.8 gave a 19% increase over V.135 in lint yield.

The bulks grown were from progenies sister to those from which the parents of the main VH Breeding Trial material were chosen with a view to making some " secondary " selections of any outstanding lines.

While seed cotton characters were lower than in the main VH trial, they were essentially similar.

R × VH Breeding Trial.—Under the high rainfall conditions which usually obtain in many parts of St. Vincent, the effect of lodging on superfine cotton has been a serious problem. The vigour of the superfine Red Sea Island stock suggested that a useful hybrid with VH might be obtained and provide some valuable breeding material. Three F_5's of the cross R × VH and three F_3's of the backcross R × VH × VH were tried against two VH progenies which were represented in the main VH trial. The comparative yield order of the progenies common to both trials was slightly different but, provided that the spinning tests are satisfactory, it would appear that some useful material for breeding has been isolated.

Discussion of VH Breeding Results.

VH.8.—Re-selections from the VH(39)7 bulk provided material from which the present progenies have been evolved. The main difference between these and other VH.8's is the high lint per boll which, coupled with the characteristic high bolling of the strain, has given a strain outstanding in yield. Since the multiple regression betas show the relative importance in yield synthesis of bolling, seeds per boll and lint per seed to be approximately 3 : 2 : 1, the comparatively low lint per seed seems of little account. It will be seen that these Breeding Trial results have been substantiated by both the Small Bulks and the Variety Trials.

VH.9.—The desirable re-combinations shown up in trials in the past season produced some of the best yielders. In the present season, however, the yields have been disappointing. In the Small Bulks and Variety Trials the yield levels have also been lower than those of the VH.8 progenies.

VH.10.—Individual progenies of this strain have been outstanding and, since the small-scale spinning tests show it to be within the V.135 range, it is considered that useful material is now available for comparative trials with V.135. The yield synthesis of VH.10 is entirely different from that of V.135, having in the main low bolling and low seeds per boll with very high lint per seed.

It is proposed, in the 81-variety trial for the next season, to make a comparison of the yield synthesis in the three VH strains, and with this in view equal numbers of progenies of each strain will be included.

Miscellaneous Experiments.

Variety Trial.—Two varieties from the United States, Bleak Hall and Seabrook, were grown in a Randomized Complete Block trial with Puerto Rico and Montserrat Sea Island, the three VH's, 8, 9 and 10, and standard V.135. Yield data are given in Table III below.

TABLE III.

Summary of Variety Trial.

Variety.	*Seed Cotton. gms.*	*Lint. gms.*	*Lint per Seed. mgms.*	*Seed Weight. mgms.*	*Ginning Percentage.*	*Lint per Acre. lb.*
M.S.I.	1,438	466	61·0	127·3	32·4	287
VH. 8	1,562	413	41·7	116·1	26·4	254
VH. 10	1,366	387	48·6	123·6	28·2	238
V.135...	1,483	348	37·7	122·4	23·5	214
Seabrook	1,198	323	46·1	123·8	27·1	199
VH.9–5	1,160	320	48·3	127·3	27·6	197
Bleak Hall	1,079	301	38·8	99·5	28·1	185
Puerto Rico	1,043	298	38·1	95·1	28·6	184
F for Varieties	**	***	V.S.	V.S.	V.S.	—

Significant differences for all yield characters were recorded. Although a considerable proportion of the total variance was removed by efficient block design, differences which could be detected were higher than 20% owing to the nature of the season.

One of the most striking features of the trial is the difference between the superfine V.135 and the ordinary Montserrat Sea Island cottons in the synthesis of yield. The VH.8 and V.135 outyielded all others in seed cotton ; in lint yield, however, the disproportionately higher lint per boll of the VH.8 and 10 and the M.S.I. offset any advantage gained by the higher bolling of V.135.

The failure of Bleak Hall to compete with local varieties under West Indian conditions is confirmed. The Seabrook, which resembles more closely the " ordinary " Sea Island cottons, does not differ markedly in yield of lint from V.135, and the within-plot variability noticeable under field conditions suggests some possibilities for breeding if there were a market demand for such a cotton.

Manurial Experiment.—3 Nitrogen (*o N, 1 N, 2 N*) × *2 Compost* (*o C, 1 C*) × *2 Superphosphate* (*o P, 1 P*) × *2 Potash* (*o K, 1 K*).

The striking results obtained from the compost experiment of the 1941–42 season suggested that a more comprehensive trial should be conducted during 1942–43. The 3×2^3 design from Yates' Tech. Comm. No. 35 was adopted to provide comparisons of all possible combinations, while keeping the block size small enough for high efficiency. The loss of information consequent on partial confounding of the two-factor and some of the three-factor interactions with blocks was of little importance in the investigation.

The limited land available necessitated the choice for the experiment of a field from which much of the top soil was removed about ten years ago. While at first sight this appeared to be unfortunate, it was subsequently realised that the impoverished sub-soil was more representative of eroded hillsides in St. Vincent than adjacent fields, and as a result might provide valuable information

regarding treatments other than nitrogen the great importance of which, to superfine V.135 cotton, has been shown repeatedly under St. Vincent conditions.

An analysis of compost showed that the inorganic equivalents of 7 tons were, for the more important constituents, 72 lb. N., 33 lb. P_2O_5 and 28 lb. K_2O per acre respectively. It is the practice at this Station to apply compost about a week before planting; for comparative purposes it was thus necessary to apply at least a portion of the inorganic treatments at the same time. The entire application of potash (as sulphate of potash) and one-third each of nitrogen (as nitrate of soda) and phosphate (as basic superphosphate) was applied at the time of application of compost. Of the remaining nitrogen and phosphate one-third of each was applied at four and eight weeks respectively after planting. A comparison of compost and its inorganic equivalent is provided by the N2PK dressing.

From the aspect of growth the decision to apply some of the fertilisers early was unfortunate. Reference to Fig. 1 shows that excess of nitrogen in the larger application has depressed plant height at 35 days. The relative unimportance of compost is reflected in yield data. The inorganic equivalent with lint yield 591 lb. per acre significantly outyielded compost with 286 lb. per acre. This comparison was not therefore included in Fig. 1.

MANURIAL EXPERIMENT 1942-43

3×2^3

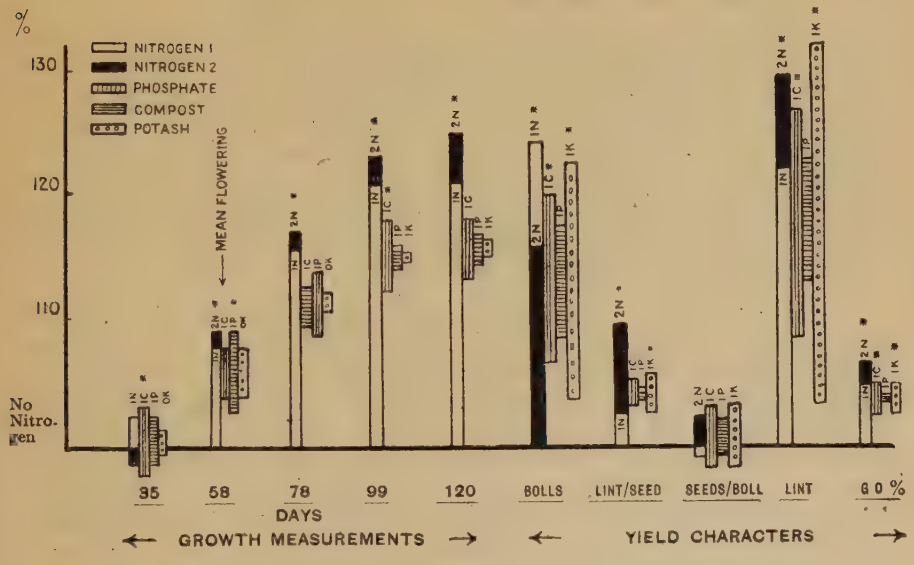

Fig. 1.

Summary of Treatment Effect Contrasts — Expressed as a percentage of on N. Significance thus *

The possibility of mechanical damage is further reflected in the bolling data. The experience of past seasons at this Station indicates usually a larger response to the heavier application of nitrogen when applied 5 or 6 weeks after planting. Potash had a depressing, though insignificant, effect on the early stages of growth. Its greatest influence, however, appears to have been after maturity when it showed an increase in bolling and subsequently in lint yield, which latter was significant. Phosphate fertilisation has been advantageous in the early stages of growth and up to the time of " budding " about 45 days after planting. The growth increments were not however reflected in any significant increase in yield.

Discussion of the Main Treatment Effects.

Nitrogen.—Inorganic nitrogen is shown in Fig. 1 to provide the greatest single stimulus to growth and yield, and it was for this reason that all contrasted comparisons were calculated as percentages of no nitrogen. The probable mechanical damage due to the larger application is reflected in the bolling data. This early negative effect was, however, eliminated by increase in lint per seed and consequently yield of lint. Growth figures show that only the smaller nitrogen application had a beneficial effect before the 58th day, and there is a possibility that leeching of excess nitrogen in the early stages of growth resulted in a somewhat lower lint yield than was expected. Past experience, confirmed by the present trial, suggests that the optimum time of application should be between the 35th and 56th day. With budding at approximately 45 days it seems likely that a small application at planting followed by the remainder at 6 weeks would give the greatest yield increment.

Potash.—In the past, behaviour of potash has been variable under St. Vincent conditions. When cotton was planted after the dry season, it was found that potash influenced yield to a greater extent than any other inorganic fertiliser. Following the change of planting season to August–September (mid-rains), when soil nitrates are probably low, nitrogen applications became the greatest single stimulus to growth, and potash apparently only gives a noticeable effect on eroded land (*see* Manurial Trial—1938–39 Annual Report). The present trial has essentially confirmed this conclusion.

Compost.—Fig. 1 shows that throughout the life of the plant compost has affected growth and yield favourably. At the same time, with insignificant two-factor interactions, CK and CN, it will be seen that yield increment has not been commensurate with that due to either of the inorganic equivalents, nitrogen or potash. This difference in the effectiveness of both nitrogen and potash in compost and the inorganic fertilisers is further shown up in difference of response to nitrogen. There were characteristic chlorophyll deficiency symptoms in all compost treatments without nitrate of soda. The significantly lower yield of lint of the compost treatment compared with the inorganic equivalent, together with the distinctive chlorophyll deficiency, suggests a lower effectiveness of nitrogen in the compost.

With insufficient evidence as to the residual effect of compost, it is not possible to draw any conclusion except that in the first year at least the inorganic constituents of compost outyielded their equivalents in compost.

Phosphate.—Other workers on fine cottons have demonstrated the essential nature of an adequate supply of phosphate in the early stages of growth, and its subsequent effect on yield. In this trial, however, no considerable increase in lint yield was obtained following the favourable effect on growth immediately preceding flowering. Phosphate in the compost and in the inorganic dressing preclude the possibility of an inadequate application, so that, for the present trial at least, its economic advantages are problematical.

Type Collection.

Maintenance of Sea Island Varieties in variable bulks was undertaken and improvement of strains in eight-plant plots, which are now standard, was carried out as usual.

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The suggestions and criticisms of the Geneticist, Cotton Research Station, Trinidad, have proved invaluable and the writer wishes to record his grateful appreciation.

PROGRAMME OF WORK FOR THE 1943-44 SEASON.

1. *Breeding Trial.*—81 Progeny Balanced Lattice Square: to include Superfine V.135, VH and all other breeding material. Selections to be based on small-scale spinning tests and basic yield synthesis.
2. *Small Bulks Trial.*—To be grown at several localities for analysis as a serial experiment: 4 VH strains against standard V.135.
3. *Manurial cum Variety Trial.*—3×2^3 Design: To investigate the differential varietal response to fertilisers of V.135, VH and M.S.I.
4. *Miscellaneous Experiments.*—To determine the mechanical effect of selfing on yield for the more important Sea Island Varieties. To continue the maintenance of Sea Island Types and Variable Bulks.
5. *V.135 Multiplication.*—Seed from non-replicated V.135 progeny rows to plant one acre of first multiplication for island's multiplication area.

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Assistant Physiologist	*Dr. E. PHILLIS

ST. VINCENT

Cotton Officer	*Mr. H. L. MANNING

† On active service. * Temporarily seconded to the Local Department of Agriculture